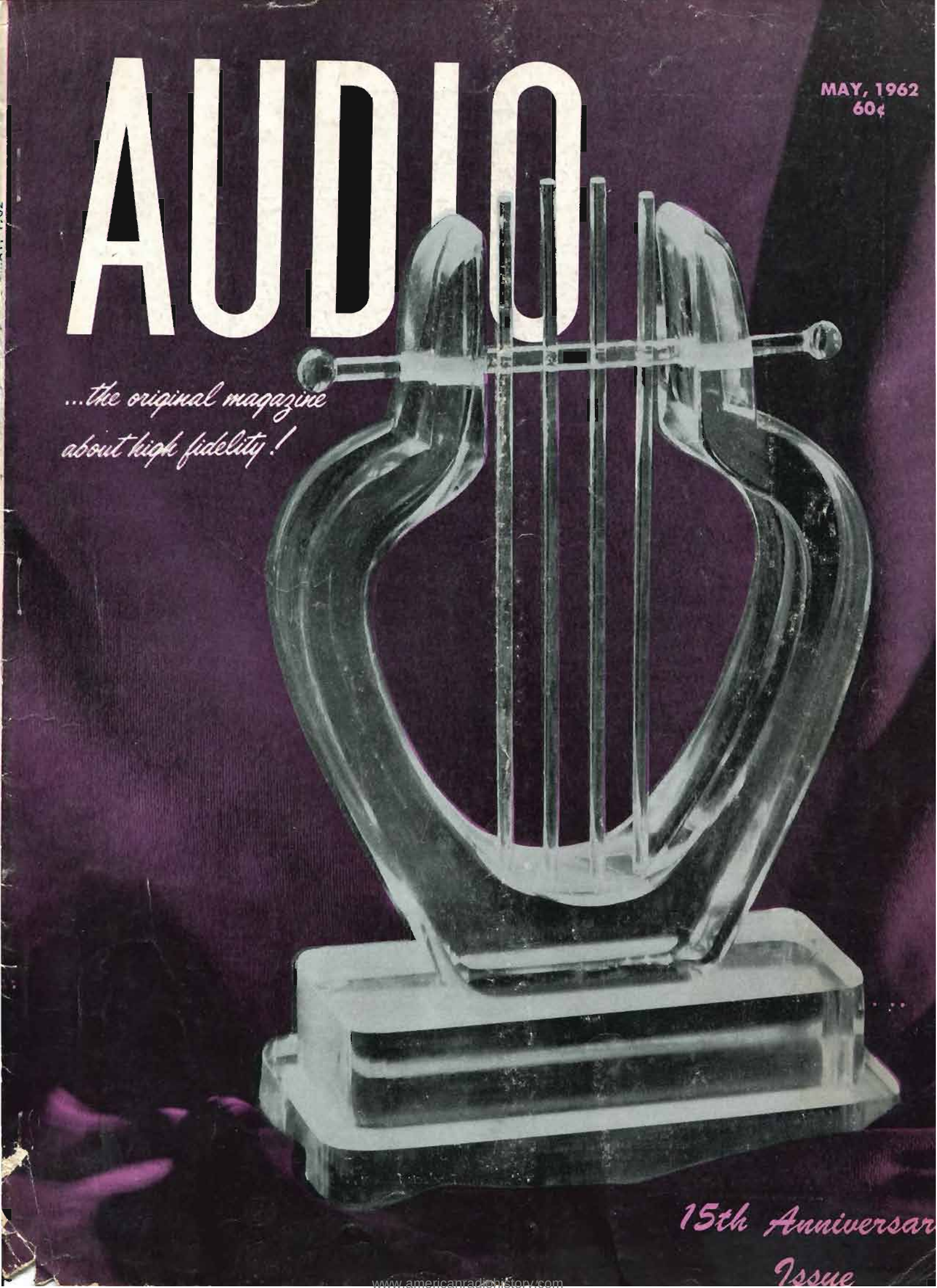
AUDIO

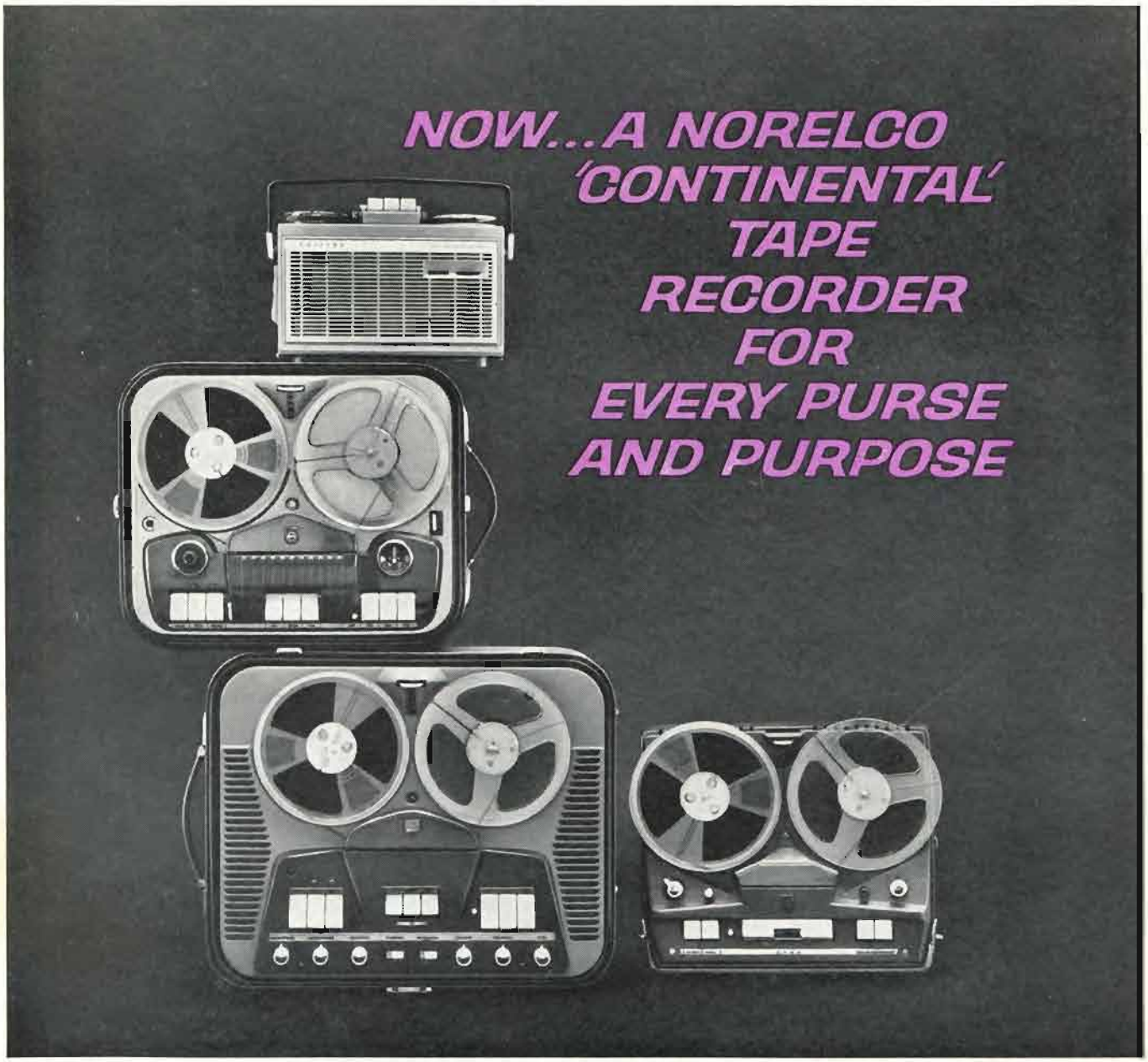
MAY, 1962
60¢

...the original magazine about high fidelity!



15th Anniversar

Issue



WHETHER YOUR PARTICULAR REQUIREMENTS IN A TAPE RECORDER ARE SIMPLE OR COMPLEX ...WHETHER THEY REFLECT THE DEMANDS OF YOUR HOBBY OR YOUR PROFESSION... WHETHER THEY STRESS LISTENING OVER RECORDING OR VICE VERSA, OR PROFESSIONAL QUALITY OVER PORTABILITY OR VICE VERSA, CHOOSING THE ONE RIGHT TAPE RECORDER FOR YOU HAS NOW BECOME AS SIMPLE AS A-B-C! FOR THERE ARE NOW FOUR NORELCO CONTINENTALS. ONE FOR EVERY PURSE. ONE FOR EVERY PURPOSE. ALL GUILD-CRAFTED BY PHILIPS OF THE NETHERLANDS. EACH DESIGNED TO PROVIDE ITS OWNER WITH THOSE FEATURES BEST SUITED TO HIS SPECIAL REQUIREMENTS—WHETHER ON VACATION, ON LOCATION, IN THE HOME, STUDIO, OFFICE, CHURCH OR SCHOOL.

CONTINENTAL '100' (EL 3585) shown on top: transistorized, 7 lb., battery portable • records 2 hours on 4" reel, from any source • plays back thru self-contained speaker as well as radio, TV or record player • response: 100-6000 cps • tapes interchangeable with other 2-track 1⅞ ips machines • constant-speed operation • complete with dynamic microphone.

CONTINENTAL '200' (EL 3541) shown bottom right: 4-track stereo head output direct to external stereo preamp for portable high fidelity tape-deck applications • completely self-contained for 4-track mono record and playback • mixing facilities • lightweight, compact, rugged • dynamic microphone.

CONTINENTAL '300' (EL 3542) second from top: 4-track stereo playback (tape head output) • self-contained 4-track mono record-playback • 3 speeds • dynamic microphone • ideal for schools, churches, recreation centers, etc. • choice of audiophiles seeking top quality at a sensible price.

CONTINENTAL '400' (EL 3536) bottom left: 4-track stereo and mono recording and playback • 3 speeds • completely self-contained, including dual recording and playback preamplifiers, dual power amplifiers, two loudspeakers and stereo dynamic microphone • frequency response: 50 to 18,000 cps at 7½ ips • wow and flutter: less than .15% at 7½ ips • signal-to-noise ratio: —48 db or better • cross-talk: —55 db.

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IN CANADA AND THROUGHOUT THE REST OF THE FREE WORLD, NORELCO CONTINENTAL IS KNOWN AS "THE PHILIPS".

AUDIO

MAY, 1962 Vol. 46, No. 5

Successor to RADIO, Est. 1917

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AUDIO Articles

AUDIO Reviews

AUDIO in General

To celebrate our 15th Anniversary . . .

AUDIO looks at the past 15 years through the eyes of C. G. McProud (p. 19); traces the development of stereo recording through anecdotes and the remembrances of R. J. Tinkham (p. 25); presents a gallery of some of the pioneers who contributed to the audio art (p. 32); and then we take a look, from a variety of viewpoints, at the development of the recording industry—the lookers are E. T. Canby (p. 12 and p. 74), H. Lawrence (p. 84), and C. Santon (p. 8). Looking the other way we have some thoughtful and thought-provoking predictions of what the next 15 years might bring (p. 68). To round out the picture, Norman Crowhurst examines the present state of the audio art in general (p. 6) while G. F. Cooper looks at the specific area of transistors (p. 22). Herman Burstein casts his experienced eye at the status quo and trends in the tape field (p. 62). As an *extra* we have presented some "new products" of the vintage 1947–48 (p. 70).

•MEMBER• INSTITUTE OF HIGH FIDELITY MANUFACTURERS, INC.

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LETTERS

On Our 180th Issue

IHFM

Congratulations to AUDIO on its 15th Anniversary!

Fifteen years of continued service to high fidelity has earned AUDIO the gratitude of the Institute of High Fidelity Manufacturers. We in the industry, and I personally, are aware of the important role AUDIO has played in the past by encouraging, and participating in, significant industry actions—not the least of which was helping to found the IHFM!

Again congratulations.

RAY PEPE,
President

AES

SIR:

The fifteenth anniversary of AUDIO reminds me that audio engineering, as we know it today, is only about fifteen years old, and that AUDIO magazine has played an important part in the development of this branch of engineering.

The Audio Engineering Society is proud of and grateful for the long history of constructive cooperation between AUDIO and the Audio Engineering Society beginning with the publication of the society's papers by AUDIO before the society had its own journal and continuing with the fine coverage of Audio Engineering Society news and features by AUDIO magazine.

The past fifteen years have seen the science of audio grow from sound reproduction only noticeably better than early radio and phonograph reproduction to a point where it is often almost impossible to determine whether the music is "live" or reproduced. We have had improvements in amplifiers, records, tapes, and tuners, providing a net improvement which would have been thought impossible a few years ago. More recently we have had stereophonic records, tapes, and multiplex FM broadcasting, providing not merely an accurate reproduction of the sounds picked up by the microphone but even a two-channel spatial representation of the original sound with equipment as easy to operate as the earlier single-channel types.

Congratulations to AUDIO on its fifteenth anniversary, and may the next fifteen years be even more rewarding.

HERMAN HOSMER SCOTT
President

MRIA

SIR:

The magnetic recording industry and AUDIO have shared an exciting decade and a half when both were young and growing.

We started first, slowly, in laboratories more than a half century earlier. We didn't reach the marketplace, however, until after World War II. It was AUDIO's first year, 1947, when the first tape—a black oxide product on paper backing—went on sale, to be followed within a few months by the now familiar plastic backing. We began to grow. Bing Crosby gave us a spectacular assist when he revolutionized the technique of broadcasting by transcribing his radio show on tape for a later release.

Tape for entertainment, however, suffered through a black and humiliating period in the late 50's when the stereo disc threatened us with extinction. Then, in 1959 at the Chicago Parts Show, a new concept in tape recording versatility—four-track stereo tape—was unveiled before newspapermen. Behind the new product was the combined energies and enthusiasms of half a hundred companies, members of MRIA, dedicated to the re-birth of music and entertainment on magnetic tape.

Today tape is on the threshold of its greatest decade. Whether it comes in a cartridge or reel-to-reel, music and entertainment on tape is the only way to achieve *original performance fidelity.* As recording and playback equipment reach even greater perfection, the choice of medium narrows even further. The greater the demand for absolute fidelity, the greater the emphasis will be on an *all-tape cycle*—from the master tape in the recording studio to the tape in the living room.

A tool of astonishing versatility, tape in other fields continues to charm old admirers and, at the same time, win new ones. Recently someone listed 207 uses for tape. While its most dramatic use is probably in the exploration of space, the greatest number of its uses has been uncovered in the field of education, where teachers in the U. S. and overseas use it as a highly effective and important teaching aid. The Peace Corps and the military, too, have discovered its value in teaching languages. It is indeed a long list that includes not only musical instruction and speech games, but job applications and reportorial interviews.

It is a list that is certain to grow in this decade which we look forward to sharing with AUDIO.

K. L. (KEN) BISHOP
President

RIAA

SIR:

Let me first extend the congratulations of the Record Industry Association of America, Inc. on the celebration by AUDIO magazine of its fifteenth anniversary.

Those fifteen years have seen your publication, as well as the record and high fidelity industries, all come of age. Some of the most significant contributions to the art of sound reproduction have come to pass in that time.

It is a period that has seen the development of the long-playing record, stereo sound, tape recording, FM-stereo radio, and a mass market for good high fidelity sound. It is a combination of these factors that made possible the growth of the record industry from a sales volume of $204 million in 1947 to around $500 million in 1961. In that same period of a little more than a decade the record industry has also grown numerically from about a dozen to several hundred important record producers. The phonograph and audio component fields have also shown tremendous growth.

Looking back over the last fifteen years I think that both you and our industry can properly feel a sense of pride and accomplishment in the contributions that we have made toward the spread of awareness and enjoyment of good music and good sound in this country.

HENRY BRIEF,
Executive Secretary

revue du SON

M'SIEU:

May 1947—May 1962. AUDIO, which first became our guide as AUDIO ENGINEERING, celebrates its fifteenth anniversary, and demonstrates for the fifteenth time the annual proof that it was not such a wild idea to believe in the success of a technical magazine devoted to everything that can be logically placed in the category of "high fidelity."

La revue du SON is happy and proud to

(*Continued on page 4*)

Garrard's New AT6 Automatic Turntable

How good can it be for only $54.50?

THE ANSWER: *So good it will excite you!*

You may be wondering, for example, whether the AT6's dynamically balanced tonearm will not only accept and track "professional" cartridges, but also bring out the best in them. Definitely yes! This is a counterweight balanced arm – the pressure being set in two steps. First – you move the counterweight until the arm floats at zero pressure. Then you merely move the indicator to the correct pressure shown on the built-in gauge, set on the side of the arm for easy reading. Once balanced, the AT6 arm will track each side of the stereo groove precisely and perfectly at the lowest pressure specified by the cartridge manufacturer. ☐ Those who know tonearms will appreciate that this type of arm was once available only as a separate component. Now it is not only yours in the AT6 but integrated – scientifically mounted to insure precision performance. But that isn't all... ☐ The turntable of the AT6 is oversized, heavy, balanced. Here, too, are the features you would expect to find in separately sold turntable units – high torque, no noise, no rumble. The motor was designed specifically to match the AT6 turntable, and built by the Garrard Laboratories to deliver perfect, constant speed, silently. It is double-shielded against magnetic hum – an important feature.

☐ Add to this such AT6 advantages as: –(1) the convenience of automatic play, when desired (automatic and single play spindles furnished), plus the luxury of being able to intermix any size, any sequence of records. (2) Design so compact that the AT6 will fit easily into any record player cabinet. ☐ Yes, if you have been wondering just how much you can expect from the AT6 Automatic Turntable at its price of $54.50, just consider these features. Better still, try one. You will be startled, and gratified, by this superb, completely up-to-date record-playing component made possible only by the unexcelled facilities and unique experience of the Garrard Laboratories.

For literature, write Dept. GE-12
Garrard Sales Corporation
Port Washington, New York

GARRARD'S AT 6 AUTOMATIC TURNTABLE

Canadian inquiries to Chas. W. Pointon, Ltd., 66 Racine Road, Rexdale, Ontario — Territories other than U.S.A. and Canada to Garrard Engineering & Mfg. Co., Ltd., Swindon, Wilts., England

AUDIO CLINIC

Joseph Giovanelli

Although there have been interesting changes in the audio field since the inception of "Audioclinic" in November, 1955, there is one area which does not change.

At that time, most of the music systems described by my correspondents were monophonic units—known then as monaural systems. Stereo records were not then in common use although there were some stereo recorded tapes—known as prerecorded tapes.

Obviously, then, the majority of requests for advice addressed to "Audioclinic" were concerned with the components which comprise a "monaural" system and the uses of each. (1962 readers who are just developing their knowledge of sound ask essentially the same questions.)

During and since the transition to stereo discs, 4-track recorded tapes and finally, multiplex broadcasting, the nature of the information requested of "Audioclinic" has changed. Today most questions deal with stereo and the techniques by which stereo is reproduced, together with requests for information about specific work each component performs in a stereo system.

The other regulars on the staff of AUDIO go into these topics in greater detail, and I shall not do so here. Rather, I think there are other points which should be mentioned which more specifically relate to "Audioclinic."

True, there have been changes in the art of reproducing high-fidelity sound, but there is one basic similarity about AUDIO readers which does not, and will not, change: the avid interest in good sound reproduction. This element is common to all of you whether you are a "do-it-yourself" enthusiast who wants to experiment, or a music listener who simply wants the optimum performance from existing components.

From the very beginning of this column, I have received many letters prefaced by the statement that the questions being asked are probably stupid, but would I answer them anyway. An analysis of these letters shows that they are not at all stupid but rather well-phrased and intelligent questions. They reflect only a lack of background in the field of sound reproduction. However, to gain this background, it is really necessary to probe into the subject—and the quickest way to probe is to ask questions of someone who has more understanding of the subject than themselves.

Answering this kind of letter is just as important as answering letters from those who are well-informed and wish more subtle types of information. Whatever you do, keep on writing. "Audioclinic" wants to help you by answering your questions.

Many of the letters received by "Audioclinic" have expressed confidence in the column. I thank you. Only by your comments can I ever know whether I am getting across to you.

On the reverse side of the coin, I have received some negative opinions of my work with "Audioclinic". These criticisms have usually been of a helpful nature and have been so received. The readers who were thoughtful enough to send them to me know my sincere feelings as expressed to them personally by letter.

Therefore, please keep your questions, suggestions, and comments coming, they are all important to me in making "Audioclinic" serve you better in the years ahead.

As many of you know, I acknowledge all mail, regardless of its suitability for use in "Audioclinic". Often the mail bag is very heavy. When that happens, it takes a while to get around to all who have written. I want to take this opportunity to thank you for your patience while waiting for an answer to your letter. Æ

LETTERS

(*from page 2*)

congratulate its illustrious predecessor and to express the sincere wish that future developments will continue to augment the renown and prestige it has achieved in the course of fifteen years of continuous efforts.

AUDIO was and remains today the technical review which audio specialists the world over consult as their basic guide. French audiomen have learned a great deal from AUDIO, not only in terms of acoustics and electronics, but in the realm of psychology, by revealing the ways in which this particular aspect of electroacoustics (poorly named, "hi-fi") contributed to the foundation of a thriving industry.

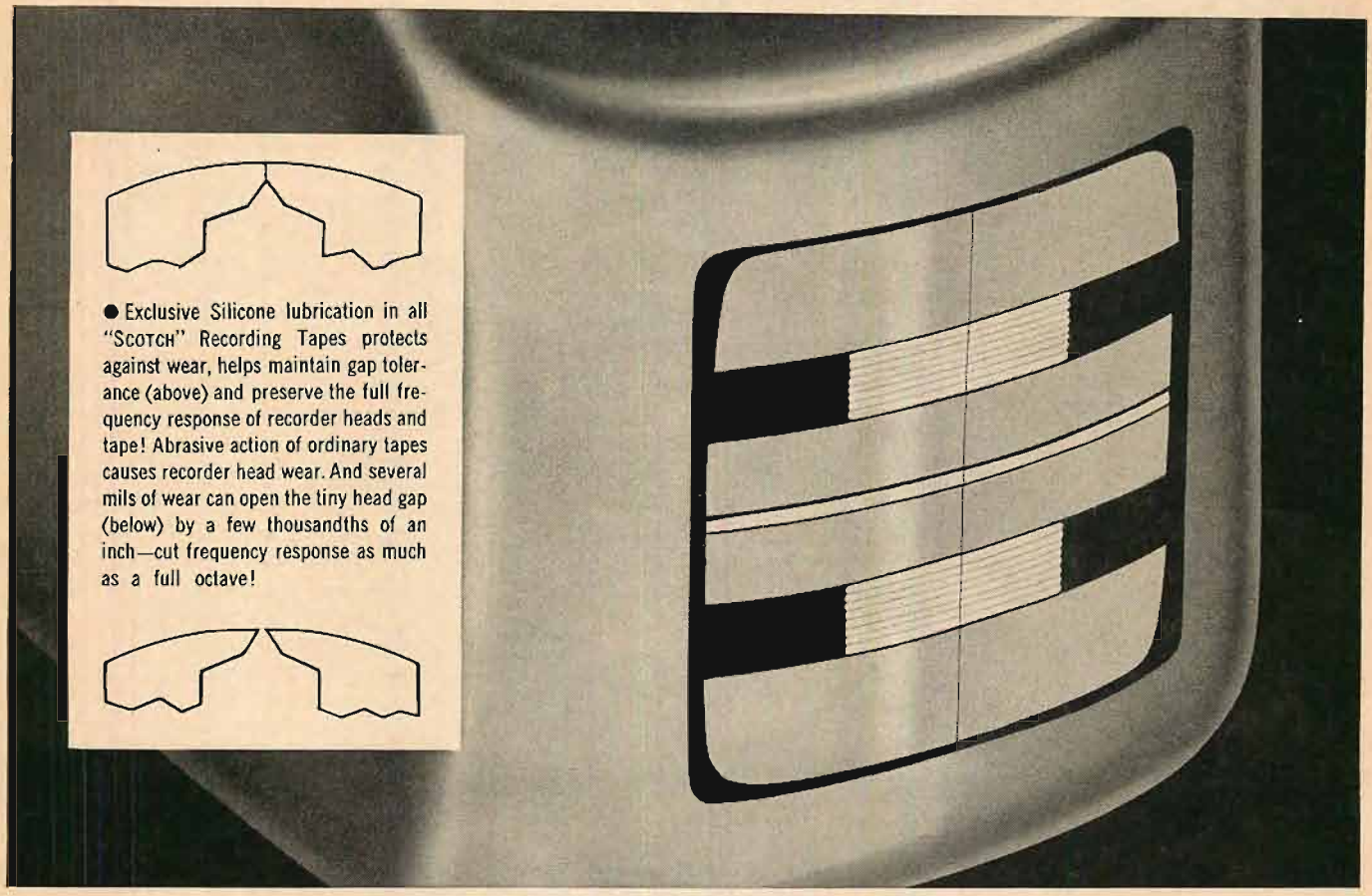
Whatever its philosophical justification, high fidelity consists in placing in the hands of a public which is mostly of layman background but which is highly conscious of sonic pleasures, equipment initially designed and created for the laboratories of sound engineers in the fields of radio broadcasting, movies, and disc recording—equipment closely related to that used by the professionals, but made accessible to consumers who possess little or no technical knowledge; equipment brought within the financial reach of constantly larger segments of the public.

AUDIO is fifteen years old. AUDIO has served us as a guide for fifteen years. Good luck, AUDIO, to you and to all those who contributed toward giving you your international fame. May you continue to guide us often during the next fifteen years.

RÉMY LAFAURIE,
Editor-in-Chief

SOUNDTALK

...from the world's most experienced manufacturer of recording tapes



How to keep your head in 4-track stereo!

EXCLUSIVE SILICONE LUBRICATION IN SCOTCH® BRAND RECORDING TAPES PROTECTS HEADS, EXTENDS TAPE LIFE!

When abrasion can actually wear away frequency response, as shown above, today's delicate 4-track recorder heads deserve tender care. They deserve the *exclusive* protection of Silicone lubrication that's available *only* in "Scotch" brand Recording Tapes and lasts the lifetime of the tape.

Silicone lubrication not only protects against wear—it extends tape life, eliminates chance of squeal by assuring smooth tape travel! Silicone lubrication is impregnated throughout the oxide coating of all "Scotch" Recording Tapes. It's completely clean and dry—nothing gummy to attract rust or clog head gap.

This built-in lubrication is one of many reasons why professionals and discriminating home recordists alike insist on "Scotch" Recording Tapes. High-potency oxides make possible thinner, more flexible coatings that ensure intimate head-to-tape contact for maximum frequency response, wide dynamic range, sharp resolution. Precise backing and coating thicknesses assure identical recording properties inch after inch, reel after reel. So to help ensure the lasting fine sound of your equipment (4, 2 or full track) we suggest you *play the favorite* . . . "Scotch" brand!

For free descriptive literature, write Magnetic Products Division, Dept. MCT-52, 3M Company, St. Paul 1, Minn.

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Magnetic Products Division 3M COMPANY

The State of the Art

NORMAN H. CROWHURST

(Photo on page 38)

THE LAST FIFTEEN YEARS have seen many changes in audio circuitry and philosophy. The upward power (s) urge has spent itself and given place to reason, feedback went to silly extremes and has come into sensible perspective, we have had various tests go through vogues—intermodulation, square-wave, tone burst, and so on. And, on the whole, audio seems to have grown up.

Power, Power, Power

On the power question, at one time the attitude was, the more power the better. Three factors seem to have eventually got this under control: first, the observation that the extra power did not produce a *commensurate* improvement in performance; second, too much power could prove costly in terms of burnt-out voice coils; and third, the advent of stereo really tamed the power urge.

Before stereo (some of us can still remember that!), the hi-fi addict could only hear the more remote parts of the music by playing it louder-and louder-and louder. Now he can hear them by use of *separation*. This probably explains why the use of stereo channels makes the volume *seem* louder with less total watts in the room; a fact which enables adequate loudness to be obtained in our own room, without producing too much unwanted sound in the next block!

Fifteen years ago, the argument called "triodes *vs.* pentodes" was still raging bitterly—lets hope it's dead by now! Before feedback, triodes undoubtedly had it for quality, pentodes for noise. But the advent of feedback and the variety of output circuits, ultra-linear, unity-coupled (both kinds) with their permutations and combinations, have changed all that. Nowadays everyone recognizes that the pentode is much more *efficient* too, and you can take your choice of circuit, according to exactly what you want from it.

Feedback

Feedback was at first seized as a cure-all. At the very first, not much was used, because the phase shift of early amplifiers would not allow more than a very few db. Then came "phase compensation," with a picofarad here and a picofarad there, enabling feedback to be

(Continued on page 88)

AKG SALUTES AUDIO

TWINS IN AGE, TWINS IN IDEALS

For a decade and a half **AUDIO** and **AKG** have striven, each in our own way, for ever-higher standards in the re-creation of sound. **AUDIO** has created in the United States an informed market, ready to welcome each new advance. **AKG**, uniting the talents of Europe's most progressive acoustical engineers and musicians, has consistently contributed the most meaningful advances in microphones and headphones. Unique in their variety and quality, **AKG** products have been welcomed warmly by broadcast, recording, and acoustical engineers, and by perceptive amateurs, the world around.

Let's see what AKG of VIENNA means by QUALITY:

Take one of their medium-price microphones, like the *D 19 B*. This dynamic directional unit has a range of 40 to 16,000 c/s, and a music/speech switch. The front-to-back-sensitivity ratio of at least 15 dB extends well down into the bass, where it's needed most. Baffling of stray magnetic fields is 18 dB. Available for 60 or 200, or 200/Hi, Ohms. Sounds good in print? Well, in use it's even better – far beyond its modest basic price of $52!

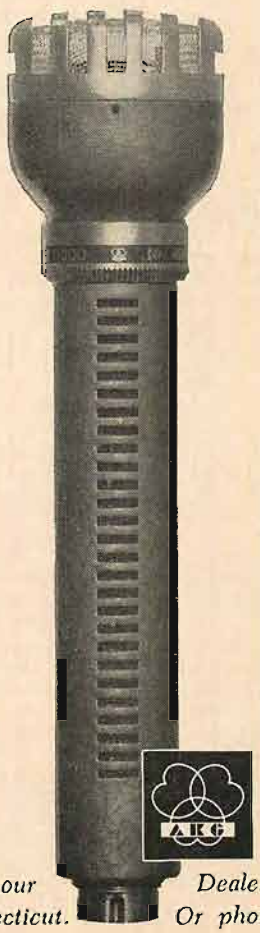
Now, how deep does this quality go?

First, feel the solidity and balance. Then note the Serial Number. This number means that, back at the factory (just as for every other AKG product from $27 to $900) there's an individual response curve and inspection report on the personality of this *D 19 B*. (Your curve is available at a slight charge).

DESIGN is based on a backlog of patents, practical experience in electronics and acoustics, engineering, and creative thinking –as in the fabulous $900 *C 24*.

MATERIALS include the noble metals and alloys, and stable plastics, selected for function and life, again as in *C 24*.

APPEARANCE shows quality – in the trim, well proportioned shape (5⅞" x 1⅜"), and sturdy elegance of the finish.



FABRICATION is strictly one-by-one. The housing is machined; sensitive elements are shock-mounted. The diaphragm is individually centered by machine screws. The whole AKG factory is a "white area". Quality control is strict and continuous from drawing board and raw materials to the final dog-tag performance test and packing.

PERFORMANCE? Just plug it in and hear for yourself. Built for 20,000 hours of service, *D 19 B* can be depended on for years to come.

For details of other AKG products, see your Dealer or write to Electronic Applications, Inc., 80 Danbury Road, Wilton, Connecticut. Or phone us at (203) POrter 2-5537.

In Canada: Eberdt Co., Montreal; McCurdy Radio, Toronto

LIGHT LISTENING

Chester Santon

FIFTEEN LIGHT YEARS

IT TAKES AN ANNIVERSARY with a good round figure to really shake loose memories of the past years in sound. In retracing the audio developments of the past decade-and-a-half in the field of light entertainment, I found myself stopping at many unexpected places in the road. In my record and tape library covering those years, most of the surprises cropped up when I dug out material that had never been played on my current equipment. The old 78-rpm discs had little to offer that was new to the ear; during the past five years I had occasionally used a venerable yet reasonably compliant pickup to transfer most of the valued items to 7½-ips tape. The interesting discoveries materialized in the LP discs of the late Forties and early Fifties when I played them with a modern mono cartridge.

In these days of bulging record catalogs, it's amazing to recall how little the early reader of AUDIO had to work with in commercial releases. Fifteen years ago, the 78-rpm record was reaching its climax in the classical field (thanks, in large part, to the efforts of London *ffrr*) but the popular and show albums of that day were raising few temperatures. Those record fans whose heels were in good enough condition, found an element of glamour in patronizing the import shops. A beautifully made HMV 78 by a little-known chap named George Melachrino was a typical prize. Heard on today's equipment, most import items still sound impressively flat and clean within their far from inconsiderable range. At that time, the guiding spirits of the small handful of domestic labels found it hard to believe that anyone could be seriously interested in the audio quality of their product. It took the development of the long-play microgroove disc in the late Forties to open the door to new labels that actually believed in the existence of listeners such as those found in the mailing lists of this magazine. Yet the high-fidelity movement of the Fifties was no great surprise to the readers of AUDIO. Most of them were already familiar with the better sound assured in the specs of components such as amplifiers, ribbon mikes, and theatre speakers. The decade of the Fifties has been an important one because it brought into the home recordings that were worthy of playback on an experimenter's best components.

My particular vantage point in broadcasting provided a few advantages during the past fifteen years that were not readily available to the average discophile. I heard just about everything issued by the recording industry on studio equipment maintained in consistently good working order. This gave me a day-by-day reference check on the performance of my own home music system. If a fault showed up in my playback gear, I resisted the temptation to blame the recording.

WHEN you consider the wealth of recorded material that was to tumble from the industry, it's rather difficult to believe how empty the larder of the audiofan was in 1959. To take just one example, the Schwann catalog of that year contained only one "sound" record. That was "Stethoscopic Heartbeats" on Columbia ML 4240. There were sound effect libraries still in existence but these were not available to the general public at the corner record shop. As a matter of fact, you had to be pretty clever to find the Columbia heartbeat record because it was listed under "Miscellaneous Collections—Classical." A few years later a sound fan could consult an enlarged copy of the same catalog and find that three other sound records had joined the heartbeats—the entire group carefully filed in the *Spoken and Miscellaneous* section of "Miscellaneous Collections." The monthly catalogs of the 1950's still reflected the influence of the 78-rpm record. Many albums of light music were mere transfers from 78's. Virtually all of the albums were issued on 10-inch LP. Bing Crosby dominated the scene with twenty-five albums. (The total number of his albums was to reach fifty by 1953). Al Jolson, almost forgotten by the present generation of record buyers, had five albums in the catalog in 1950. In mood music, Paul Weston was deeply entrenched with seven albums. The foreign contingent among the mood makers had already established a foothold. At the turn of the decade, Mantovani was just another name in a list that included Stanley Black, Robert Farnon, and Ronnie Munro. A year or so later, Mantovani was to hit the big time with his "sweeping strings" arrangement of "Charmaine"—first as a single, then as part of an album.

The ten-inch format then prevalent in the trade undoubtedly had a lot to do with the solid success of light music on microgroove. In pre-discount days, prominent labels such as Capitol, Columbia, Decca, Mercury, and M-G-M were available at $2.85. RCA Victor and Vox sold their ten inchers at $3.85 while London maintained its "prestige" import image by charging $3.95. The average quota of tunes was eight to an album. The customer generally got good value because the industry was recording mostly top-drawer music in building its catalogs. It took the smart boys in the marketing departments three of four years to figure out ways to pad a pop album with four more tunes and sell it in the higher-priced twelve-inch format.

In 1950, the "Original Broadway Cast" album was already top dog in earnings in the light field. The big shows, to no one's surprise, were available only on twelve-inch disc.

Two of the early deluxe sets offered Broadway plays on the Decca label at $11.70—"Death of a Salesman" and T. S. Eliot's "Cocktail Party." "South Pacific" and "Kiss Me Kate" were riding high and pulling up the stature of the entire industry with them. These two albums probably sold more record buyers on the practical advantages of LP than all the early classical 33⅓-rpm releases rolled together. The idea of a long playing record was never to be questioned in the industry after the sales figures of these two albums were tallied at the end of their first six months on the market. Such albums also encouraged a lot of independent producers to come into the burgeoning record business with labels of their own. Because distribution was a real problem for the early indies, some of these labels were to disappear in a few years. How many of us today can recall 1950 labels such as Paradox, Treasure Chest, REM, or Griffon? Other equally optimistic outfits included Horace Heidt Records, Arco, Alco, Regent, Imperial, Continental, and Standard. On the other hand, many labels well known today weren't in existence in 1950.

LOOKING BACK at the roster of labels active during that year, perhaps the most significant name missing from the list is that of Emory Cook. During the Fall of 1950, Cook was busy prowling the yards and trackage of the New York Central Railroad with top-grade recording equipment and a gleam in his eye that probably went unnoticed by the train crews with whom he came in contact. By the time he finished his rounds, appointed and otherwise, Cook had a recording that was to shake most of the recording industry out of its lethargy and start the high-fidelity era we still have with us today. His ten-inch disc called "Rail Dynamics" was the first widely-distributed commercial record to meet, and in some instances exceed, the specifications of the higher-priced sound components then on the market. Most of us realized at the time that much of the success of "Rail Dynamics" (Cook 1070) was traceable to the feedback cutter used in getting all of that sound into the grooves of the record. As the years passed by and playback equipment underwent gradual improvement, it became obvious that everything that went into the making of the early Cook records was of a quality years ahead of its time. 1070 is the real landmark. Of all the train sounds on this disc, the most impressive one today is the fabulous impact of steam transients recorded at very close range. Other mono Cook/Sounds of Our Times releases in my collection, many of them now out of print, sound as good or better than mono discs that came out ten years later. For example, "Music Boxes of Long Ago" (Cook 1012) still rivals in range and clarity anything else on the subject in the catalog today. The Carlos Montoya Flamenco sessions were, and still are, models of that type of recording. For true presence on closeup mono recording of voices, the Trio Leones of Cabrito recorded on location in a restaurant south of the border is a unique document in any collection. The value of these recordings transcends the immediate pleasure they provided in the audio salons or the listener's home. When demonstrated on good equipment, the Cook recordings provided the first effective argument that could be used in attempting to convince the major labels that their records could be improved in quality of sound. No small part of that argument was the resounding commercial success of the Cook discs at a time when the record industry was finally persuaded to begin weighing the merit of

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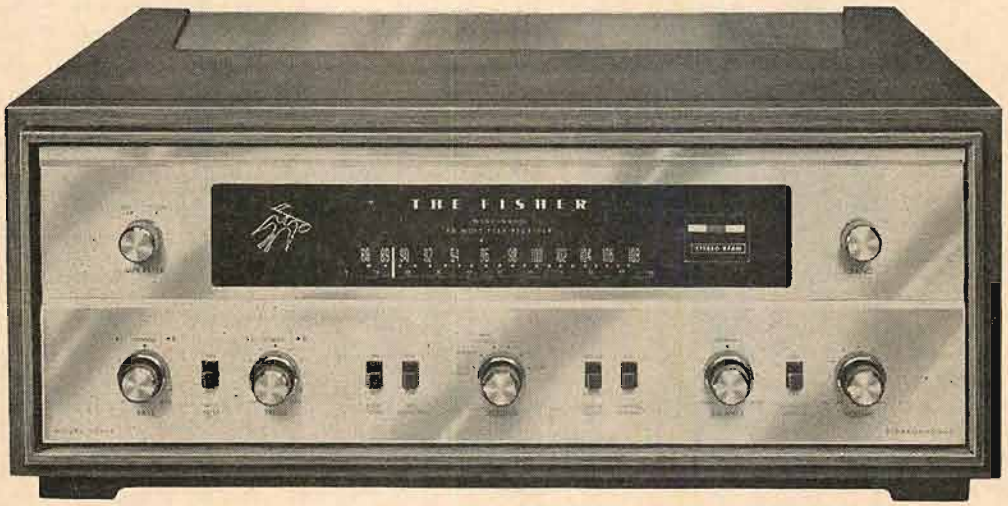

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HF 501

its mikes, amplifiers and cutters. Cook was not the only label nudging the big outfits in the early Fifties. Peter Bartok, Vanguard, Westminster, Montilla, EMS, Esoteric, and Mercury were labels doing excellent pioneer work but most of their efforts were devoted to classical music. All of these companies were active in 1953 but in the Spring of that year only one label was competing with Cook in the production of sounds on records. That outfit was Folkways. Its two releases, "Sounds of the South American Rain Forest" (X-120) and "Sounds of the Sea" (X-121), had the distinction of being the most expensive twelve-inch releases on the market at $6.95 a disc. It is true that ingredients of more than average expense went into the production of these pressings but the price was also based on the assumption that the owner of a high-performance sound system would be willing to pay that price for unusual program material; and pay it he did.

An even more expensive proposition was set before the record buyer when Emory Cook introduced his version of the stereo record in the early Fifties. Called "binaural" records by some, these discs had half the playing time of conventional mono records because channal A occupied half of the record and channel B the other half. The two mono pickups (invariably Pickerings whenever Cook demonstrated the system) were mounted on a dual arm that engaged the two bands simultaneously This technique offered all the separation you wanted in the full range of sound then available on mono disc. The Achilles heel of the system, however turned out to be something that was quite unrelated to the cost in terms of playing time per record side.

When I began a program series for audiofans on WQXR in the autumn of 1953, one of my FM-AM stereo broadcasts was devoted to an hour of Cook dual-band stereo records. I never expect to live through a more harrowing hour than that one in two-channel broadcasting. On the afternoon of the broadcast, Emory Cook brought down from Stamford, Conn. the table and dual arm he had been using in his demonstrations. Whatever shaking the unit took in the trip to New York so unnerved the two arms that Emory himself could get the bands to synchronize only on every third try or so—hardly a good batting average for air work. The studio engineer rehearsed those two arms for several hours before air time and then managed to broadcast all six records successfully by patiently cueing and recueing each pair of bands until they were working in unison. At the end of the broadcast the man was a shambles and Emory possibly had begun to entertain his first doubts about the future of dual-arm stereo.

In comparison, two-track stereo tapes, when they came along a few years later, seemed like child's play. Channel balance and distortion varied from one release to another but the process itself was manageable. The 7½-ips two-track product, when played with heads of a relatively wide gap then in use, did not have the treble response we were accustomed to on the better-quality mono discs. The early duplicating process did not lend itself to the standards of quality control then possible in the manufacture of discs. As usual, the lighter releases on two-track stereo tape escaped the problem that has always plagued classical recordings. Background noise on popular music tapes did not crop up the way it

(*Continued on page 86*)

JULIAN D. HIRSCH
of Hirsch-Houck
Laboratories

Summing up his report for HI-FI STEREO REVIEW, Julian D. Hirsch wrote: "*In my opinion, the UNIVERSITY CLASSIC MARK II . . . is one of a limited group of speakers to which I would give an unqualified topnotch rating.*"

"Despite the popularity of bookshelf-size speaker systems, the big speaker system is far from extinct. There is still a great deal to be said for the sound quality of a really good large speaker system, one of which is University's new Classic Mark II.

In operation, the Classic Mark II handles low frequencies up to 150 cps through a 15-inch high-compliance woofer that is installed in a ducted-port cabinet. The bulk of musical program content, however, is handled by an 8-inch mid-range speaker, which covers from 150 to 3,000 cps. Above 3,000 cps, a Sphericon super tweeter takes over.

The measured indoor frequency response of the Classic Mark II was remarkably uniform. As a rule, such response curves are so far from flat that I do not attempt to correct them for the slight irregularities of the microphone's response. However, the measurements for the Classic Mark II prompted me to plot the microphone response also. This further emphasizes the uniformity of the system's frequency response. A 5-db increase in the setting of the tweeter-level control would probably have brought the range above 3,000 cps into nearly exact conformity with the microphone-calibration curve.

The low-frequency distortion of the woofer, even at a 10-watt input level, was very low, and it actually decreased at 20 cps, where the output was beginning to rise . . . Any good amplifier of 10 watts rating or better should be able to drive it satisfactorily.

In listening tests, the Classic Mark II sounded very clean . . . there was an undercurrent of bass, more often felt than heard, that was completely lacking in some other quite good speaker systems that I compared to the Classic Mark II. The speaker sounded at its best (to my ears) at moderate listening levels. At high levels the bass tended to be overpowering. A different listening room, of course, could easily alter this situation completely. Over-all, the sound was beautifully balanced, with wide dispersion and a feeling of exceptional ease. There was never a hint that three separate speakers were operating; the sound seemed to emanate from a large, unified source.

In my opinion the University Classic Mark II justifies the substantial claims that its manufacturer has made for it. It is one of a limited group of speakers to which I would give an unqualified topnotch rating. Anyone who is in a position to consider a system of its size and price would be well advised to hear it. The price of the system is $295.00."

WRITE TODAY FOR THE COMPLETE JULIAN HIRSCH HI-FI STEREO REVIEW REPORT on the new CLASSIC, as well as the documented CLASSIC brochure and "Informal Guide to Component Stereo High Fidelity." Simply write: Desk R-5, University Loudspeakers, 80 S. Kensico Ave., White Plains, New York.

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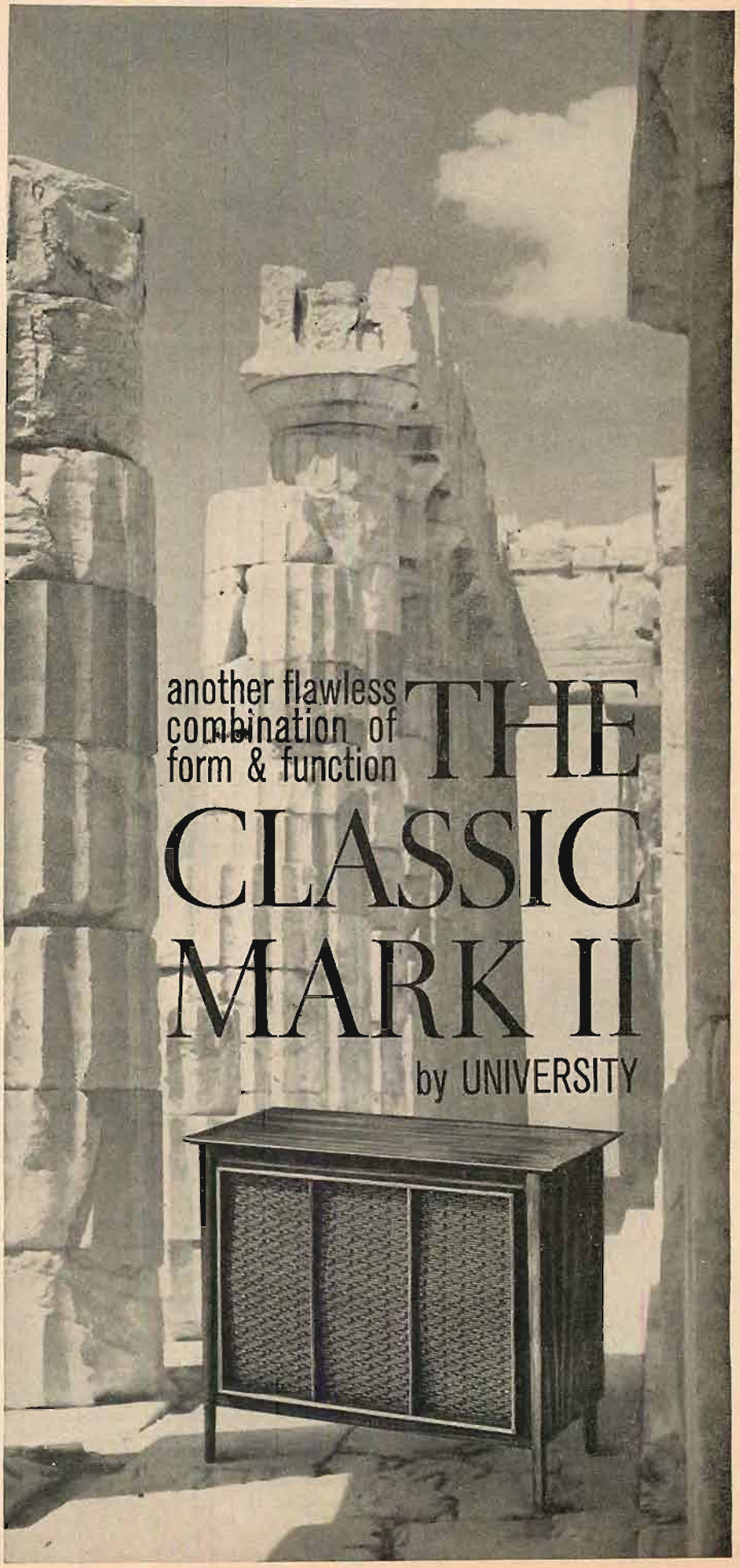


AUDIO ETC.

Edward Tatnall Canby

THE REVOLVING ANNIVERSARY—OUR FIFTH IN RECORDS

Instead of concentrating on our 15th Anniversary, Mr. Canby has decided to concentrate on our 5th anniversary (1952) which we seem to have neglected editorially—ED.

Banner Year

As I look back on that Fifth Anniversary year, I'm amazed—it was a time of feverish activity in the entire sound world with hi-fi as we know it today, in all its aspects, just about ready to burst wide open. It was a time when developments came faster than you could keep track, when controversies raged with enthusiasm over matters now long since settled and forgotten. It was, that year, a time of free-wheeling free-thinking as to hi-fi standards—and an equally free-wheeling tolerance on the part of the hi-fi audience. Anything went.

And it was in that year the LP record really took off in respect to quality of sound, thereby at last giving the audiophile something to play on his rig. It's this that interests me most about 1952.

So I've spent an absorbing time, just now, doing what I *never* do ordinarily, going back with a new purpose over a group of real old LP records, straight out of the 1952 period. A rare experience!

I could only shop around a bit among the 1952-period records I have on my shelves. There are hundreds of them. But when I started after those which I had specifically reviewed in the May issue of 1952, ten years ago, I found the usual distressing absenteeism. Don't ask me where they go, my records! I keep cards on them, but somehow they quietly vanish. The ones I want, that is. There are plenty of others. There's always the number *next* to the one I want. LM 1142 is missing but LM 1143 looks out at me hopefully—"will I do instead?" It'll have to do, under the circumstances. A near-miss, anyhow.

I found a good many that I was looking for, even so, and I pulled out some likely stand-ins, too, according to my certain knowledge. Mercury's 50000, the first Olympian recording, first of the "Living Presence" discs, wasn't there. Natch. (If *you* borrowed it, kindly return at once.) But 50004, one of the very first group, could stand in for it very well. And so it went. I sampled a good many discs, all in all (my ears wouldn't take more), and I quickly found myself trying to pin down how these old records sounded, what they had in common, as of 1952, how they differed collectively from our present output. Several times, just to see, I put on a brand new stereo LP (played mono for a more objective comparison); but it wasn't really necessary—the 1952 crop spoke for itself. So did my 1952 record reviews, which I proceeded to check by playing, to find how my present feeling would line up with that of ten years ago. Strange and interesting. (See RECORD REVUE.)

I am speaking here, of course, of recorded sound quality, not music. Music is not quite as changeable as audio. Musical changes in ten years are significant, but I honestly found that the sound and character of the older records themselves, after ten years, was of greater interest and significance to me. (Look back fifteen years, to our first issue, and you have only 78's. I have very few of *them* left, I can tell you. 1947 was a thin year for records, to put it mildly. It's a wonder I got this job at all.)

Equalization—What's That?

First thing I noticed, of course, was how completely we now have put aside all discussion of record equalization. Extraordinary! If you weren't around audio ten years ago, three years before RIAA, you can have no idea of the degree of preoccupation with problems of record "curves," of boosts, roll-offs, turnovers, NAB, AES, LON, VIC, OLD COL, NEW COL and a dozen more alphabetized cryptograms, that was typical of every one of us who made or played a record! Or made a hi-fi amplifier. Unbelievable, and all because the gentlemen of the record industry had a batch of honest but violent differences as to how a record ought to be made and, subsequently, played.

Everybody had his own curve (and half of them didn't tell you what it was, either—if they knew themselves). Every hi-fi man had his equalizer. Half of his time was spent "matching" records.—i.e., twiddling knobs and pushing buttons. The other half was spent studying complex charts that purported to give the precise dope on every brand of record available, old or new. The charts, of course, seldom agreed. No matter—you studied them until your eyes were bleary.

Everybody did something about it, of course. But they all did it differently. We at AUDIO (still called AUDIO Engineering, the last half in smaller type, getting still smaller)—we promoted compromise; if I remember, there was an AUDIO curve; then it was merged with the AES curve, proposed, a bit too early, as a standard for all. (It wasn't far from the RIAA standard that did arrive some three years later.)

But though the LP itself was accepted even by RCA (and the 45 by Columbia), the details of record making were dismally unstandardized and, in truth, record equalization was vitally important for any home listener. That was a big subject with me in my 1952 record reviews, and I threw out some wild and woolly guesses, too! But I find that in the main I was right. The old records do, indeed, differ startlingly, as played today.

The only semi-standard 1952 curve—still available now as an alternative on a good many new amplifier control panels—was the Columbia-NAB curve, introduced with the original LP. Its highs were sharper than ours and they must be reduced more than the RIAA position allows, or the sound will be strident. The bass was screwy (almost literally—it had a reverse twist); but that is less important for the ear. All Columbia LP records played optimumly on this position and, equally important, all of the many small-label records then being pressed by Columbia. Westminster, for instance. Vox. Plenty more. *Almost* a standard.

But RCA, of course, was as different as it could manage to be. No self-respecting RCA LP of those days would play rightly on a Columbia equalization! Other disc curves fell but vaguely into the RCA camp, though one could never be sure. And London *ffrr* went its own dignified and cryptic way; all we could figure was that *ffrrs* didn't sound like *any* of the other records when it came to equalizing. They still don't, the old ones.

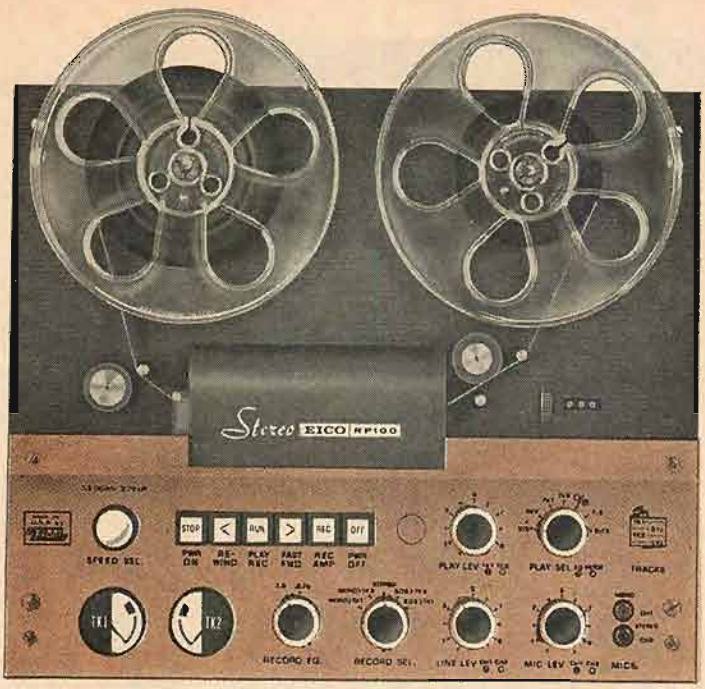
I find today that with our really vastly improved playing equipment the difference in audible distortion between one 1952-style disc and another is very much clearer than it was then. With the state of the pickup art and the then loudspeakers in general use (these are the vital transducers, where macro-distortion was likely to occur), a good deal of recorded distortion was masked by the over-all uncleanliness of the playing system. This is significant in its reflection back into recording itself, as I'll be observing below.

I will not name names—most are still very much with us—but I must say that the popular mono pickups I was then using were not quite up to present production. Loudspeakers, too, were generally more highly "colored" than now, on the average. And so, to my pleasure, I've found some outstandingly "clean" discs in my 1952 explorations—as played on 1962 equipment; but also some disturbingly unclean ones. My estimates of them in 1952 reviews were somewhat liberal, I'll admit. We were more tolerant of distortion then, simply because we heard it so much of the time, hi-fi claims or no. After all, have we been standing still these ten long years?

I found one interesting and unremembered phenomenon in these old records. A "clean" 1952-style record, as now played, tends to be able to take a very considerable high (or bass) boost (as well as a cut) without showing undue unpleasantness. It is thus quite easy to get good sound out of these clean older discs in spite of the unstandard equalization. Just swing your tone controls around until a natural sound emerges. The record will not be demanding, the leeway surprisingly large.

The flexibility of recorded sound under such an equalization treatment is a good outward indication of its tonal cleanliness.

On the other hand, a "jiggered-up" 1952 sound, peaked and rolled, turns out now to be strangely resistant to any equalization on modern equipment. Odd! There were plenty such records in those days, and a lot of them were jiggered deliberately for effect, as I know very well, having seen it actually happening in some *very* high places. Also from first-hand contacts with some of the boys who had to do it for their respective bosses. (Now, it's the tricks of reverb and what-not that get attention.) Other records were jiggered by accident, thanks to inadequate equipment and/or unskilled use of it all along the line.



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The Hollow Sound

Equalization aside, the most striking aspect of these 1952 type records was the acoustical quality of their sound, whether distorted or no. How mightily have we changed! How drastically different is our current mike technique and its new-fangled adjuncts in mixing and reverbing!

Nowadays, it's all reverberation. In 1952, though halls were as reverberant as they are today and many recordings were made in the very same places they are now, ten years later, the *recorded* effect is surprisingly different. I used to think that the old and dignified pre-war 78 classics were the real "dead" recordings; now, in 1962, I see that in comparison to today's new sound, the 1952 norm was relatively close to that of the pre-war period. It was generally not as dead. But it shared a certain abrupt, unreverberant spatial effect that, to my astonishment, I now find quite objectionable. Obviously, I was wholly unaware of it in 1952. My own printed remarks say so.

You see, it isn't only an increase in recorded reverberation, though that is a big element in the change. The present sound, born of the stereo age, is immensely full-bottomed and large-bodied. Perhaps artificial reverb, added in various ways, makes the difference; but I suspect the new multi-mike stereo techniques have a lot to do with it. (In 1952 Mercury used a single microphone for its Olympian Living Presence series, launched that year. Now the company uses "only" three mikes for its stereo Living Presence.) Yet even the dual-mike (one-point or cross-mike) European techniques now manage to get a good deal of the "new sound" quality into today's discs. There's more to it.

There is no single factor. No two recording engineers will agree, indeed, as to what these subtle differences involve, nor what is the proper procedure for producing today's optimum recording. Each has his miking secrets, as always. And yet, by golly, you can spot a 1952-period recorded sound quite easily; it is as much like its neighbors on other discs as a 1952 Plymouth resembles a '52 Ford.

Anyhow, these older records for my 1962 ears rather strikingly lack some mysteriously active kind of presence and aliveness that our mike artists know how to achieve—and this quite over and above their varying lack of tonal purity. The older sound is somehow *hollow* to me. That is, the spaces in which the music is heard are unimpressive, even with a properly longish reverb time. They seem pinched, confined, smallish in impact, belying their actual size. Carnegie Hall is smaller than life, not larger. It isn't spread out in my room, before me; it is heard through a hole in the wall, and the hole isn't big enough, even via two stereo loudspeakers playing in mono.

I find remarkable, then, what we have managed to do today, via technical progress, via increased mike know-how *and* via ear-education. Our musical ears have been working hard right along, you see, keeping up with the technical progress in recording and microphoning; we now can enjoy and *interpret*, in terms of musical re-creation, types of sound that in 1952 (not to mention 1947!) would have been ugly and semi-meaningless to most of us. I suggest that in this teaming-up of ears and technology we are now able to make a lot more illusion out of what we have to work with. Our music is bigger, fuller, realer, more immediate to us, whether the instruments are

(*Continued on page 76*)

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EDITOR'S REVIEW

THIS MONTH'S COVER

Shown on the cover this month is a crystal lyre AUDIO had made for this occasion in Italy by the glass-blowing firm of Bruno Polacco & Co. of Venice. The lyre is made of crystal to symbolize our 15th Anniversary; the crystal was made in the shape of a lyre because that is the symbol of the IHFM (Institute of High Fidelity Manufacturers). Bringing these seemingly unrelated facts together, AUDIO, as its contribution to this celebration, is presenting this lyre to the IHFM, an association dedicated to the furtherance of high quality sound reproduction. We are presenting the lyre because the manufacturers who constitute the Institute have been of great service to the audiofan, our readers, by consistently providing superior products and promoting the concept of component-quality sound reproduction. It could truthfully be said that very few audiofans would be experiencing high fidelity today were it not for these manufacturers.

With this token we recognize the contribution of the IHFM.

AUDIO CLUBS?

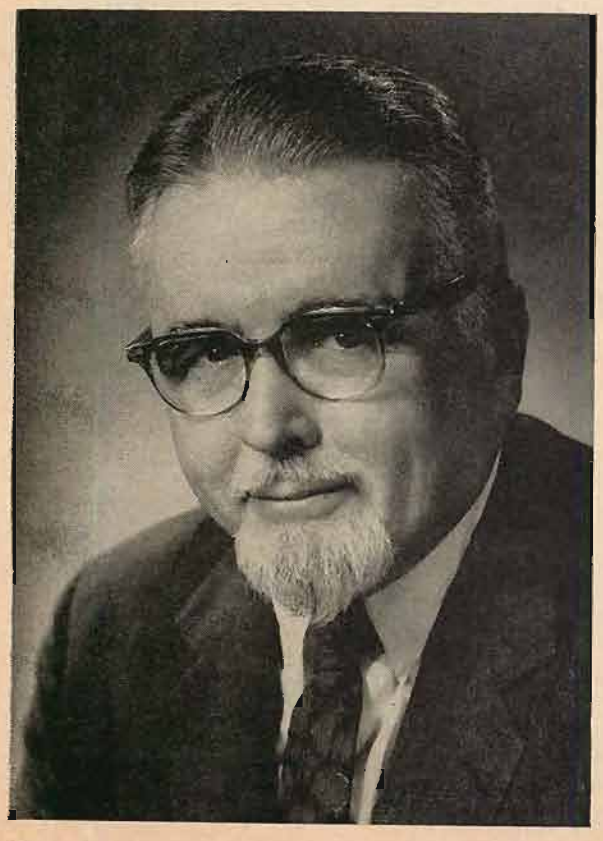
Over the past few years, at shows and other such gatherings, many audiofans have indicated to us an interest in joining with other audiofans in their locality for the purpose of comparing, sharing, and learning. "After all," one said, "fans in other fields advance their knowledge and their hobby by forming clubs, so why not audiofans?"

Well, we couldn't answer his question for him but we did promise to help those AUDIO readers who wish to form a club. We'll do it in the following way: (1) we will transmit back to a particular locality the names of those people in that area who wish to form a club; and (2) we will provide space in AUDIO for an exchange of ideas between local groups.

In order for us to help you here is what *you* must do: (1) write to us; and (2) indicate whether you are willing to act as a central point in your area until the club is formed.

FACES

You will notice that we have provided new column headings for most of our regular staff features—the basic difference being the inclusion of a line drawing of the columnist. To round out the "picture" we present below photographs of the Publisher and the Editor. (Aren't anamorphic lenses wonderful?)

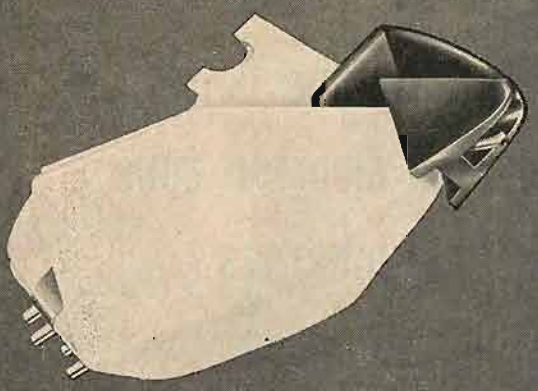


C. G. McProud
Publisher

David Saslaw
Editor

At Last!

A CARTRIDGE DESIGNED ESPECIALLY FOR AUTOMATIC TURNTABLES!



A NEW KIND OF CARTRIDGE FOR A TOTALLY NEW REQUIREMENT!

...AND ANY OTHER AUTOMATIC TURNTABLE EVER TO BE MADE!

The Pickering Model U38/AT is a cartridge designed especially for the new generation of automatic turntables. A true STANTON Stereo Fluxvalve, it combines excellent hum shielding with high output for unequalled signal-to-noise ratio.

High compliance is provided for the special turntable features while preserving the ruggedness demanded by automatic operation. Improved frequency response and lower inductance make the new Pickering U38/AT a truly universal cartridge to match the universal features of the automatic turntable.

TECHNICANA: PICKERING Model U38/AT is a STANTON Stereo Fluxvalve with a white body and black V-GUARD stylus assembly. Weight is 14 grams; Mounting centers: 7/16" to 1/2". Supplied with universal mounting hardware. $46.50 AUDIOPHILE NET

RESPONSE: ± 2 db from 20 to 20,000 cycles.
CHANNEL SEPARATION: 35 db
OUTPUT: 10 mv each channel
TRACKING FORCE: 2 to 5 grams
IMPEDANCE: 47,000 to 100,000 ohms
SHIELDING: Complete mu-metal

"FOR THOSE WHO CAN HEAR THE DIFFERENCE"

PICKERING & COMPANY, INC., Plainview, N. Y.

The hermetically sealed STANTON Stereo Fluxvalve is warranted for a lifetime and is covered under the following patents: U.S. Patent No. 2,917,590; Great Britain No. 783,372; Commonwealth of Canada No. 605,673; Japan No. 261,203; and other patents are pending throughout the world.

50,000,000 tube hours... an unusual electron tube still keeps undersea voice signals strong

Deep on ocean floors, from North America to Europe, between Key West and Havana, Florida and Puerto Rico, under the Pacific to Hawaii and Alaska—in 20,000 miles of undersea telephone cable—a special kind of electron tube is setting a remarkable record for reliability.

This four-inch-long electron tube was designed, developed and fabricated at Bell Telephone Laboratories to operate with no attention for 20 years or more. It is part of the submarine cable repeater manufactured by Western Electric which faithfully and reliably amplifies voice signals transmitted along undersea coaxial cables.

All of the 1608 tubes built into the repeaters have operated to date without failure for a total of over 50,000,000 tube hours, or an average of three-and-a-half years. The oldest have been in service since the first deep-sea repeatered telephone cable was laid 12 years ago.

Years before it was put to use, Bell Laboratories scientists and engineers began developing this undersea tube, another example of forward-looking technology that has made the Bell Telephone Laboratories the world center of communications research and development.

BELL TELEPHONE LABORATORIES

15 Years of AUDIO

C. G. McPROUD

The history of AUDIO is closely tied up with that of the whole high fidelity industry—and we even started first. But as long as there is hi-fi, there also will be a dedicated staff who have labored long and hard to keep ahead of the field.

THE YEAR IS 1947. High fidelity is a limited hobby enjoyed by a few dedicated individuals who may have had contact with the professional aspects of sound reproduction and who couldn't enjoy coming home to what passed for radio and phonograph reproduction as exemplified by the then available equipment. To make sure of having a good amplifier, one had to scrounge one from a broadcast station or the local movie house. The same sources were constantly searched for loudspeakers which would recreate music to satisfy the critical listener.

In contrast to most hobbies, there was no common meeting-ground wherein Paul from Boston could exchange ideas with Harry in Dallas or Marty in San Diego. Neither could the music lover in Miami communicate with his counterpart in Upperplate, Wyoming.

Then came AUDIO ENGINEERING—the first magazine devoted to the sound engineer, ostensibly, but with a strong feeling for the problems of the audiofan who might be a surgeon, dentist, accountant, or college student during the major part of his day. To be sure, Æ was quite technical in its first years—and many of the earlier readers express a desire that we should go back to them—but with the growth of the Audio Engineering Society and the emergence of its *Journal*, the highly technical articles have a place for publication for a relatively small membership, while AUDIO strives to furnish good reading, accurate technical information, and general help to the striving audiofan.

Fig. 1. The cover of the first issue of **Audio Engineering** introduced Norman Pickering to the professional audio engineer.

John H. Potts
1892-1949

Fig. 2. The late John H. Potts, co-founder and first editor of **Audio Engineering.**

The first issue of AUDIO ENGINEERING, May, 1947, showed Norman Pickering on its cover, reproduced in *Fig. 1*, with his then new low-stylus-force, high-compliance magnetic pickup which appeared in cartridge form a few months later as the first magnetic pickup of professional quality intended for home use. The second issue, *Fig.* 3, showed an RCA Master Sound Console on the cover and carried a descriptive story inside. For six months, everybody was saying, "It's a great issue, but how long can they keep it up?"

Figure 4 shows more covers from '47 and '48—the first with one of the first published photos of an anechoic chamber and the remander devoted to master and studio control facilities of radio stations.

For almost two years the AUDIO tradition grew under the editorship of John H. Potts, *Fig.* 2, who died on March 16, 1949. After his death the trend toward the audiofan grew more rapidly, in step with the trend toward more equipment intended for home use and offered by a small handful of manufacturers.

Since there was then relatively little commercially available equipment except that made for broadcast stations and other professional users, Æ had a strong leaning toward the do-it-yourselfer. Scores of articles describing home-built amplifiers graced the pages of Æ over those early years—but always tucked in among the more serious articles. The popularization of the Williamson amplifier in the U.S. dates from November, 1949, when the story of the "Musician's Amplifier" was published. The Ultra-Linear circuit was first brought to the public eye by Dave Hafler and Herb Keroes in November, 1951.

AUDIO Firsts

Aware of the potentialities of the hi-fi field, Æ always endeavored to be the first to introduce any new idea. For example, the loudness control—a well compensated device which has been credited with

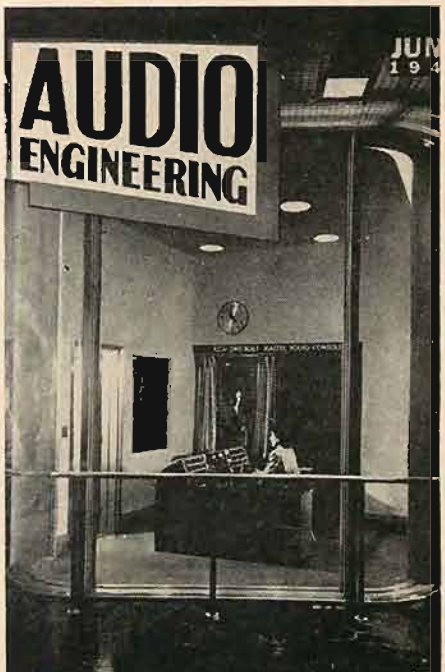


Fig. 3. Cover of the second issue of Æ, June, 1947.

Fig. 4. Four of the earlier covers of the magazine: August, 1947, showing an anechoic chamber; December, 1947, and July and December, 1948, each with radio station installations.

having brought hi-fi out of the basement into the living room—was published in the May, 1948, issue. The same issue also told of an elaborate "echo chamber" built by KFI in Los Angeles for radio station use, and copied in various forms since then for home reverberation devices.

The first "feeling out" of readership on the subject of an Audio Engineering Society was in the form of a "planted" letter early in 1948, resulting in the formation of the Society later that same year—and Æ was represented on the steering Committee that did all the early work, and later on the Board of Governors and finally as President.

The back-loaded corner speaker was first introduced in Æ in the January and February issues of 1949—and many commercial speakers followed the design in varying degrees of imitation. And later in 1949 the first exhibit of audio equipment was planned at Æ and the name Audio Fair was given to provide a simple title that was euphoneous and easy to remember. Unfortunately the Audio Engineering Society—the sponsor of the show—did nothing to protect the proprietary rights to the name and so lost them. But even though the official name of the annual hi-fi show is now different, the old title still sticks unofficially amongst the old-timers.

Other firsts include a complete issue on stereo just at the time the multiplex story broke—a lucky accident, it later appeared. Then, too, there was the first article describing how to modify a common G-E monophonic cartridge for stereo, a number of articles about matrixing and two-channel switching and controlling, as well as others about the latest types of stereo control amplifiers. And, of course, the greatest "scoop" of all—five articles on the FCC-approved system for FM-stereo in the readers' hands only forty days after the decision was announced—at least a full month before any other magazine published any technical details whatsoever.

Over the years the front cover of Æ has gradually shifted from the professional to the home user. There was even a brief interlude of an insert "magazine within a magazine" called *Video Engineering*, but that was only a flash in the pan, so to speak. *Figure* 5 shows more covers ranging from ultrasonics to the home installation. In order to appeal more to the audiofan, the "Engineering" was dropped from the title beginning in January, 1954, and in February a whole new cover design appeared—the one at the far right in *Fig.* 5. The designer of the new cover, Leo Leonni, felt that because of the diversity of subject material inside the book, the cover should show something technical and something not technical—hence the schematic along with a photo of a home installation or equipment for some months. Late in 1957 another cover design evolved which has continued up to now—but this month's cover should not be considered another "permanent" change.

Actually, of course, the appearance

Fig. 5. Four more early covers: April, 1949, illustrating some ultrasonic experiments; March, 1950, the first of the short-lived **Video Engineering** inserts; January, 1951, with four home-type amplifiers using different tube types; and March, 1955, with a new cover style.

Fig. 6. Lead photo for the first definitive Williamson article in the U.S.A., November, 1949.

of the inside of the book has not changed much over the years. We feel the reader will become accustomed to a certain style and arrangement, and would prefer it to remain reasonably constant—something familiar about each issue from month to month. Maybe some readers would prefer more variety—how does one tell without trying it out?—and then it might be too late to change back. We do strive to be accurate technically and to use consistent and correct grammar and punctuation, however. We see no reason why a semi-technical magazine should use less than correct English.

Covering the Field

The gentle art of high fidelity comprises more than equipment. Not only are amplifiers and turntables and tape recorders and loudspeakers all parts of the whole system—so also are the sources of music or sounds that are played through them. Thus from the first issue of AUDIO ENGINEERING in 1947 to the present, considerable space has been devoted to record reviews. On the classical turntable is Edward Tatnall Canby, who has been the mainstay of the record reviewing staff for fifteen years and who is also fairly typical of the non-technical audiofan. He has an intense curiosity about equipment and he also has ten thumbs—as he so often says. But he is a good guinea pig for new ideas—and if they are musically good, he is one of the first to espouse them. Charlie Robertson is a jazz buff at heart—and a newspaper reporter by profession. Chet Santon is a dignified announcer over the air, and an enthusiast for the "listenable" type of music. Harold Lawrence, a record company A & R man by profession, is full of interesting sidelights on music in general. Joe Giovanelli builds has own ham equipment, repairs TV and radio sets for friends, and has for a current project the construction of a top-quality tape recorder for his own professional use. Herman Burstein is an economist when he's working and a tape hobbyist when he's not. The most recent staff contributor, Norman Crowhurst, is an engineer-turned-writer with a flair for the tutorial—his TEASERS are just that.

Industry Relations

AUDIO recognizes its responsibility to the entire high fidelity industry. We feel that the hi-fi press should be fair to the reader in its presentation of new ideas—something different. Ideas that are just gimmicks should, in our opinion, be brushed off in keeping with their actual importance. On the other hand, the press should co-operate with manufacturers and their organizations whenever and however possible—opposing when it is believed necessary—but always offering a solid front to the public eye. If we do not always acclaim something as the greatest thing since the invention of the automobile, for example, it may be because we firmly believe it isn't. And that is our basic policy—if the reader is served honestly and well, the entire industry will benefit. And we believe also in co-operation between the members of the industry—exemplified by the Institute of High Fidelity Manufacturers. 'Way back in 1953 we proposed the formation of the Audio Council. Nothing happened then, but in 1955 the IHFM came into being. This year we proposed something else—and now we'll just wait and see what happens to that idea.

The Last Words—of the 180th issue

High fidelity is a serious hobby to those who pursue it—these audiofans put a lot of time and money and heart and soul into it, and they expect a lot of satisfaction in return. We at AUDIO have the same hobby, really, and we enjoy being of whatever help we can to our fellow hobbyists. So we pledge for the next Fifteen Years to carry on in the same vein—improving whenever we can, but always trying to help the reader —and, in so doing, ourselves. Æ

Fig. 7. Covers up to date: October, 1956, with a drawing of the action of a transistor and a circular horn loudspeaker; April, 1957, with a simple transistor circuit and another home-built speaker enclosure; January, 1958, with the first published photo of a stereo record cutter; and April, 1959, with typical hi-fi room settings.

High Fidelity with Transistors

GEORGE FLETCHER COOPER

When the proofs, the figures, were ranged in columns before me;
When I was shown the charts and diagrams to add, divide and measure them,
How soon unaccountable I became tired and sick.
Walt Whitman

MOST OF US KNOW THIS FEELING: it strikes me with particular violence when I see a 10,000 word article on, let us say, recent advances in bio-electrical instrumentation at the Cape Horn Entomological Institute. I do not hear Whitman's voice, but Lewis Carroll's Bellman, exclaiming *"Oh, skip your dear uncle—."* If, therefore, the reader feels that

"The line too labours and the words move slow"

I beg him to remember that I am not free to skip forty years. Nor, as it happens, is that my wish: it is rather exciting to see that the transistor is, at last or so soon, however you look at it, really breaking into the audio field. This is the Fifteenth Anniversary Issue of AUDIO: fifteen years ago there were no transistors at all. A few, a *very* few years ago, if you wanted more than a few milliwatts of power you had to accept quality which you would hardly accept from your telephone. Now we have at least what you may call fairly high fidelity.

This qualified approval is probably unfair. Professionally we have moved with tube amplifiers from the 1-per-cent distortion of the late thirties to the 0.1 per cent of the early fifties. In general, it seems that the transistor amplifiers have broken through the 1-per-cent barrier but have not yet made the 0.1 per cent, but this may be because it looks better to claim 20 watts at 0.5 per cent than 10 watts at 0.1 per cent. The trouble is that the men who write the brochures read Walt Whitman and they think that we do not want the proofs, the figures, the charts, the diagrams.

Probably more important than the 1-per-cent distortion figure is the breakthrough in the 3–4000-cps figure. Just how high you need to go in the frequency spectrum is anybody's guess: the European professional standard used to be 16,000 cps for broadcast material sent over lines from one country to another. Since the problem here is to avoid international arguments about which country

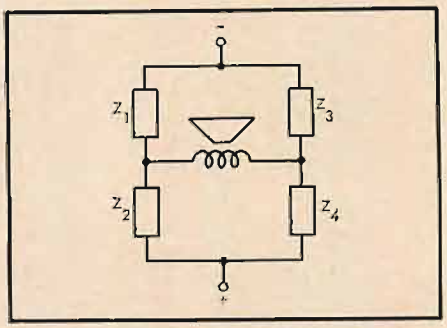


Fig. 1. Generalized bridge circuit which is the basis for all OTL circuits.

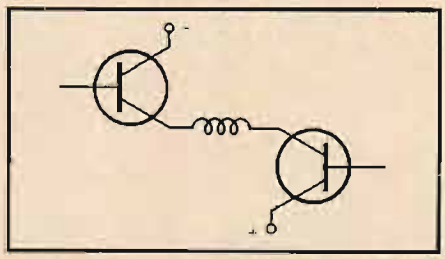


Fig. 2. Current path during one-half cycle in Class-B system. Each transistor may be n-p-n or p-n-p.

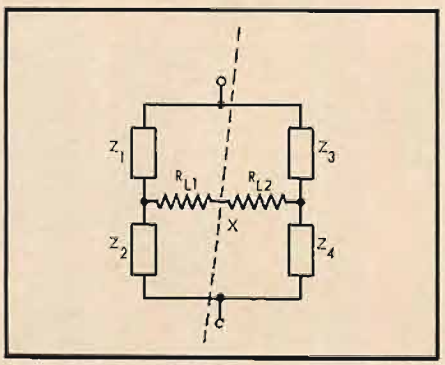


Fig. 3. With truly balanced operation the centerline is a nodal axis and X can be located to give us two half bridges.

lost the highs if a listener complained, that is probably a sensible and safe number to take. The new transistor amplifiers have broken right through this and are generally flat up to 20,000 cps or more.

We have, I suppose, three topics. How has it been done, who has done it and where do we go from here. It is simpler than the world of criminology, where you must ask, How, When, Where, Why, and Who, for When is now and Why is, well, if you do not know why designers are at work you are very lucky.

How can be divided into two parts. Let us look at the background first. The real key to the advance in performance is the development of suitable transistors at a suitable price. The audio frequency transistor as we knew it only a few years ago just would not allow us to get high quality: the diffused-base power transistors with common emitter cut-off frequencies around one megacycle make the whole feedback problem almost child's play. Indeed, it is only necessary to get power transistors which have a common-emitter cut-off frequency of, say 30 kilocycles and low-level transistors giving high-frequency performance to be able to break through to high fidelity.

Added to this we have an attitude of mind. The circuits which are now being used are complex and represent a level which I do not think we have had previously in the domestic field: indeed, they appear to be more complex than the submarine repeater which I saw in development just a week ago. To some extent this reflects limitations in the devices themselves and it also, I suspect, reflects a determination on the part of the designers to achieve the wanted performance in spite of the devices.

Transistors introduce quite a few new problems and some advantages. The low impedance of transistor circuits is a mixed blessing. As we shall see, it enables us to get rid of the output transformer. In return we find that we must use electrolytic capacitors: the last time I was told they were completely reliable nowadays I showed the salesman a Claim Form awaiting my signature from an engineer who was shot by one exploding. It is true that the catastrophic failures I have met have all been on high voltage types. A few years ago we even found electrolytics in the bass-boost networks, but they have mostly gone and the new

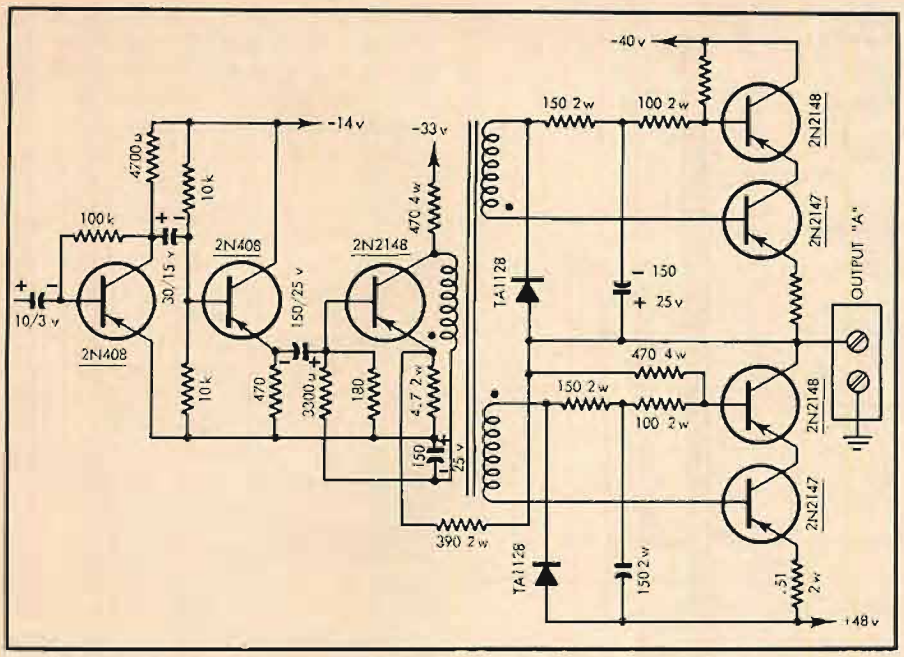


Fig. 4. Variation of basic circuit used in particular amplifier, Knight KN-450.

circuits should have more stable frequency characteristics.

Complementary symmetry is another advantage which the transistor designer has at his service. Combinations of n-p-n and p-n-p transistors have an extra degree of freedom which is especially useful in the later stages of an amplifier where impedances are getting lower and where we must make the transition from single-ended to push-pull. The resulting configurations have no tube equivalents.

Noise we might expect to be rather worse with transistor amplifiers: after all, one can get heater hum, unweighted, down below Johnson noise. It is easier to smooth high-voltage low-current supplies than low-voltage high-current, while transistors still make some noise of their own. The figures given for noise are thoroughly satisfactory, however.

Microphony just does not come into the picture any more and I feel that we shall see this affecting future designs. Self-heating is, in some ways, a related feature. One manufacturer claims that his 40-watt stereo pair dissipates only 2 watts when quiescent compared with 150 watts for the equivalent tube system. At full load, of course, the input power and the dissipation rise, but the total power is only 60 watts and the power wasted is mainly wasted at the output transistors. Thus not only is there much less heat but the heat is generated at a small number of points and can be carried away by air flow without warming up the other components. The over-all result is that a complete stereo amplifier system takes up no more space than a single-channel tube preamplifier.

The present state of design indicates that the shaking-down process has hardly begun. New designs will move towards a common pattern: if I knew what that would be I should be in business. The first common feature we can see as probable in the future is the bridge output circuit. In *Fig.* 1 we see the arrangement in its theoretical form. There are several practical forms, which is why such a bare abstract form is shown as a beginning. It is safe to assume that there are no Class-A circuits in the mail to confuse the issue and we shall assume that we will always be dealing with Class B. I refuse to distinguish these subtle variations around the cut-off point. From some points of view the simplest form of *Fig.* 1 uses a transistor as each impedance. Considering one half cycle, Z_2 and and Z_3 are cut off so that the circuit becomes just the speaker coil in series with two transistors as shown in *Fig.* 2. If the draftsman has not betrayed me you should not be able to identify the emitters: that is a deliberate omission, for various p-n-p, n-p-n combinations are possible although the circuits so far at hand show only p-n-p transistors right at the output. The other half-cycle, with Z_1 and Z_4 cut off, uses Z_2 and Z_3 in series. In this arrangement the peak voltages across the speech coil is equal to the supply voltage minus twice the transistor saturation voltage: the peak voltage across any transistor is the supply voltage.

The basic alternative is to make Z_3 and Z_4 short circuits at signal frequencies. If we redraw *Fig.* 1 as shown in *Fig.* 3, with the load (the speech coil) split in two, we can see that in the four-transistor bridge we have skew-symmetry about the center-line and therefore the point X should not move. Half the power is in R_{L1} and half is in R_{L2}. Since X should not move we tie it firmly down. Now R_{L1} cannot know what happens to the right of the center line so we eliminate all the circuit there and we are left with Z_1, Z_2, R_{L1}, and the joint for point X. Some designers use a capacitor, which can be returned to either side of the supply line: others split the supply and return X to the center point. If a single capacitor is used, there is some danger that the difference in quiescent currents in the two transistors may cause the steady value of the potential at X to drift away from the half-supply-voltage point. The peak swing across the speech coil (now R_{L1}) is equal to the half-supply voltage if this does not happen but is reduced by the amount of drift. Resistors, or complex feedback circuits, can be used to reduce this effect and the split-supply can be regarded as a particular low-d.c.-impedance way of getting good centering.

The full benefit of the bridge of half-bridge OTL structures is obtained if there is no driver transformer. We find that it is here that complication really begins. One transistor in each arm of the bridge, or one transistor in the half-bridge, can be driven by a p-n-p unit acting as an emitter follower: some designers will obviously choose to form a Darlington pair. The other transistor is usually driven by a common emitter

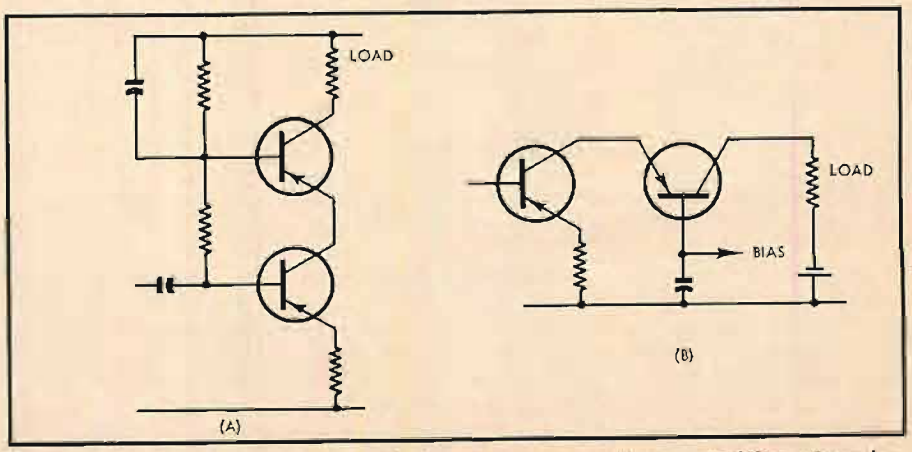


Fig. 5. The cascode circuit, grounded-emitter grounded-base amplifier gives low internal impedance.

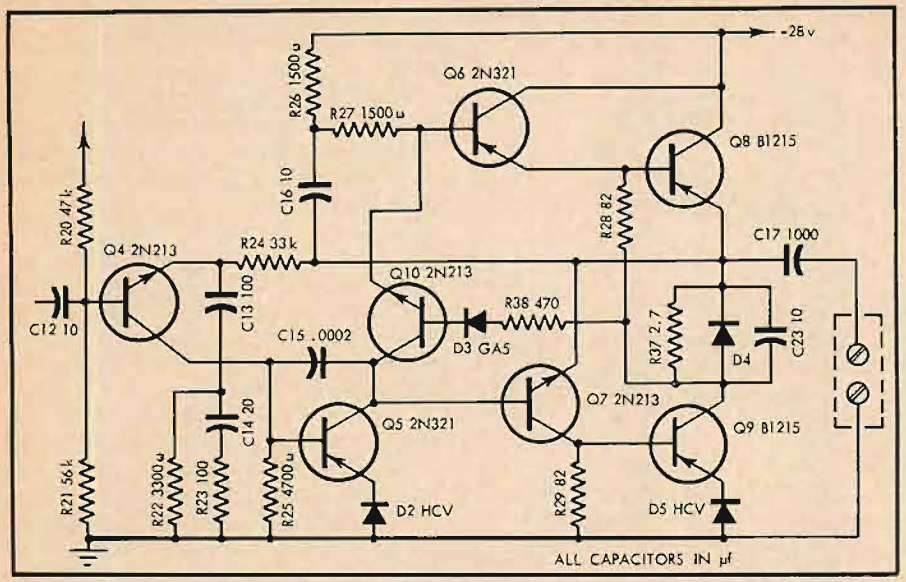


Fig. 6. Output circuit used in TEC S-15 amplifier.

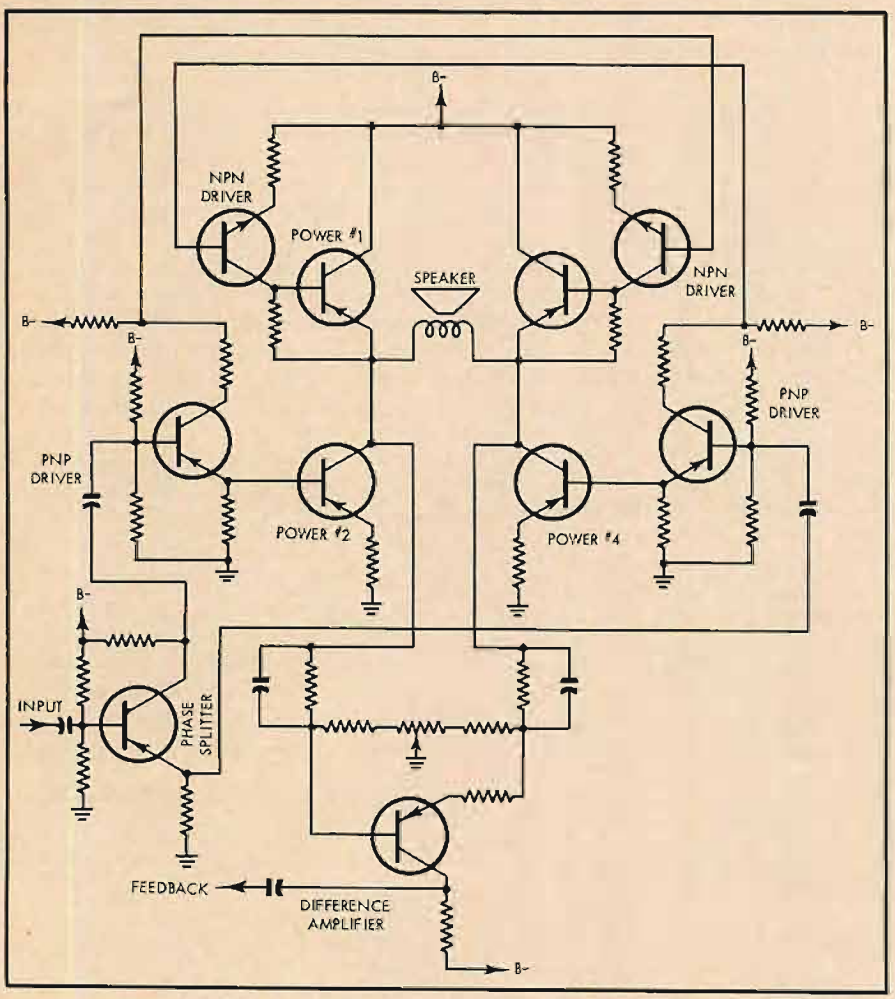


Fig. 7. Output circuit of Omega 1600 amplifier.

n-p-n transistor with a small collector load and sometimes, though not always, with a substantial amount of local negative feedback from an undecoupled emitter resistance. It is in the provision of drive to these two stages that we see the most interesting variations.

The variation shown in *Fig.* 4 is relatively uncomplicated and used a driver transformer, as you can see from the circuit. The output stage looks pretty odd at first but each side of the half-bridge is in fact a cascode circuit, a common-emitter stage driving a common-base stage. This has low internal feedback and enables a high supply voltage to be used. The textbook drawing of the cascode is shown, with its simple skeleton, in (A) and (B) of *Fig.* 5. The driver transistor is, of course, a power transistor. In the circuit of *Fig.* 4 the feedback is very simple, just a resistor connected between the live end of the speaker and the emitter of the driver transistor but in a version of this circuit described by RCA the ground end of the speaker is taken through a small resistor in the driver emitter lead to provide current feedback as well.

A feature of the cascode circuit is that with the high voltage, some 80 volts centered on ground, it becomes worthwhile to provide a supply which is virtually a twin supply. The circuit of *Fig.* 4 runs one half-wave rectifier into the negative line, starting with –40 v. for the output stage and dropping through a succession of RC filters to feed the earlier stages with lower and quieter supplies, while a second half-wave rectifier, in the opposite sense, provides a positive 42-volt line for the other half of the output stage. If the output stage is fully driven there should be 40 volts peak across the speaker.

The circuit shown in *Fig.* 6 is also a half-bridge but, more conventionally, perhaps, in terms of current trends, uses a Darlington stage and a stage with a grounded-emitter n-p-n driver for the two active branches of the half-bridge. The supply here is a single-ended 28 volts so that a battery can be used. A large rectifier and a resistor added in the battery lead would let you keep the battery floating if you wanted to be sure of continuous working through a power failure.

The third of the American circuits is shown in Fig. 7. This is a full bridge and each of the power transistors has its own directly coupled driver. The four power transistors are connected in a basic symmetrical bridge configuration. This allows the maximum peak-to-peak voltage appearing across the load (speaker) to approach twice the d.c. power supply potential. In general, reliability and supply potential are inversely related. The use of four power transistors—rather than two—has the added advantage of lower power dissipation in each unit. The power transistors which constitute the four active arms of the bridge are driven in pairs. When transistor 1 is conducting, transistor 4 conducts and transistors 2 and 3 do not conduct. Similarly, when 2 and 3 conduct, 1 and 4 do not. Associated with each of the power transistors is a driver transistor. Power transistors 2 and 4 are driven by emitter-follower p-n-p units in phase opposition. Their input signal is derived from a conventional transistor phase-splitter circuit. Power transistors 1 and 3 are driven by n-p-n units connected as common-emitter amplifiers. The input signal to the n-p-n units is

(Continued on page 82)

Anecdotal History of Stereophonic Recording

RUSSELL J. TINKHAM*

Reminiscences about the birth of stereo by one of the early participants.

IN THIS FAST-MOVING TECHNOLOGICAL AGE, we often take new developments for granted. We're amazed briefly, then accept the situation and hurry on with our own business. Only in our leisure moments do we find time to wonder how something has come about, and wonder about the motivations and trials of the people involved, and perhaps about what really went on behind the scenes.

It was inevitable, of course, since we have two ears, that someone would try to find a better way to use them for listening. After all, in the 1800's we'd had binoculars and stereo pictures for the eyes . . .

In 1892, just sixteen short years after Alexander G. Bell's historic "Mr. Watson, come here, I want you," the first intelligible telephonic transmission, Bell demonstrated a binaural telephone. This was one of the scientific attractions at the world's Columbian Exposition in Chicago. Two telephones were set up in one room, and the listener, in an adjoining room, clamped a receiver to each of his ears. He could tell the position from which a person in the first room was speaking.

Forty years later, in 1933, at the Century of Progress Exposition in Chicago, Bell Telephone Company showed "Oscar," the tailor's dummy, with two microphones set into the sides of his head. Oscar was in a small glass booth with a closed curtain between him and the thirty or forty people facing him. Each one held a pair of receivers clamped to his two ears. Each listener sensed that someone was moving around behind him, pouring water into a glass, or jangling keys, or dropping things on the floor, or whispering into one or the other of his ears. It took a strong-willed person not to look behind himself! Then the curtain opened to reveal a well-dressed Oscar standing with his back to the listeners, and a real, live man walking around inside the glass enclosure performing those many sound tricks once again.

The year after Mr. Bell transmitted that first speech, Mr. Edison, on July 30, 1877, filed for a British patent on his tinfoil phonograph. Twenty-one or -two years later (1898 or '99) the Columbia Phonograph Company offered for sale, at $1000.00, the Multiplex Graphophone Grand (*Fig.* 1), the first known three-track (simultaneous) phonograph.[1] This was a conventional cylinder phonograph except that it used "Three Separate Reproducers acting in absolute unison with three separate and distinct records (on the same cylinder) . . . The tones of the Multiplex are far more faithful to the original rendition of voice or instrument than those of any other talking machine. This fact is due to greater discrimination in the process of recording, rendered possible only by the use of separate recording horns and styluses." But they didn't call it "stereo"—or even "binaural." At $1000.00, this machine would now cost about $4000.00 based on the comparative purchasing power of the dollar. Can anybody think hi-fi stereo prices are high today? Yet this machine was certainly the forerunner of quite an industry.

Of course, the objective of all developments along these lines has been to achieve naturalness and realism in the reproduction of music and sound. The ideal is the recreation of the concert hall in the living room (or placing the living room in the concert hall), a neat acousti-


The Multiplex Graphophone Grand

THE LATEST DEVELOPMENT IN THE GRAPHOPHONE

This new instrument was built for exhibition at the PARIS EXPOSITION.

A Talking Machine having the Volume of Several Grand Instruments Reproducing in unison.

The most wonderful sound-reproducing mechanism ever constructed. In volume, the voice of the Multiplex overwhelms the tones of the earlier talking machines as the roar of Niagara's cataract drowns the brook's gurgle.

IT CONTAINS NEW FEATURES IN ADDITION TO THOSE THAT CREATED SUCH A PROFOUND SENSATION WHEN EMBODIED IN THE GRAPHOPHONE GRAND.

IT USES

Three Separate Reproducers

ACTING IN ABSOLUTE UNISON WITH THREE SEPARATE AND DISTINCT RECORDS.

Each one of which gives the same loud, pure tone as that of the Graphophone Grand. The combination of all three in unison gives

AN INTENSITY OF VOLUME

AND A

SWEETNESS AND RICHNESS OF TONE

Which seem almost beyond belief.

THE tones of the MULTIPLEX are far more faithful to the original rendition of voice or instrument than those of any other talking machine. This fact is due to greater discrimination in the process of recording, rendered possible only by the use of separate recording horns and styluses.

The three reproducers are entirely independent one from another, yet so arranged as to reproduce in unison. Results are obtained that it is difficult to realize are within the possibilities of sound reproducing mechanism.

The Multiplex can be converted in an instant into

A GRAPHOPHONE GRAND OF TRIPLE SIZE

by using only one reproducer to cover the entire length of the cylinder.

Special records may be had which will thus give a reproduction ten minutes long.

Designed especially for exhibition purposes at the Paris Exposition, the Multiplex Graphophone Grand is not listed in our catalogue nor carried in our regular stock of machines. But the results obtained from it are so superb, and its reproductions so marvelously faithful, both in volume and tone, to the real voice or instrument, that we have decided to make machines and records of the Multiplex type to order, confidently assuring those who purchase them that they represent the very highest development in the art of sound reproduction.

MULTIPLEX GRAPHOPHONE GRAND

INCLUDING

3 Recorders,
3 Reproducers,
1 Special Triple Horn Stand,
3 56-inch Brass Horns,
12 Multiplex Grand Records,
6 Multiplex Grand Blanks.

$1,000

COLUMBIA PHONOGRAPH COMPANY,

NEW YORK, 168, 168 Broadway; Retail Branch, 1154, 1157, 1158 Broadway; CHICAGO, 88 Wabash Ave.; ST. LOUIS, 930-932 Olive St.; PHILADELPHIA, 1004 Chestnut St.; BALTIMORE, 124 E. Baltimore St.; CINCINNATI, 18 E. Fourth St.; WASHINGTON, 919 Pennsylvania Ave.; BUFFALO, 838 Main St.; SAN FRANCISCO, 788 Market St.; LONDON, 128 Oxford Street, W.; PARIS, 34 Boulevard des Italiens; BERLIN, 68 A Friedrichstrasse.

Fig. 1. Facsimile of ad for the first known three-track reproducer. (Reprinted from "From Tin Foil to Stereo," copyright 1959 by Howard W. Sams & Co., Indianapolis, Ind.)

* *Vega Electronics Corporation, Cupertino, Calif.*

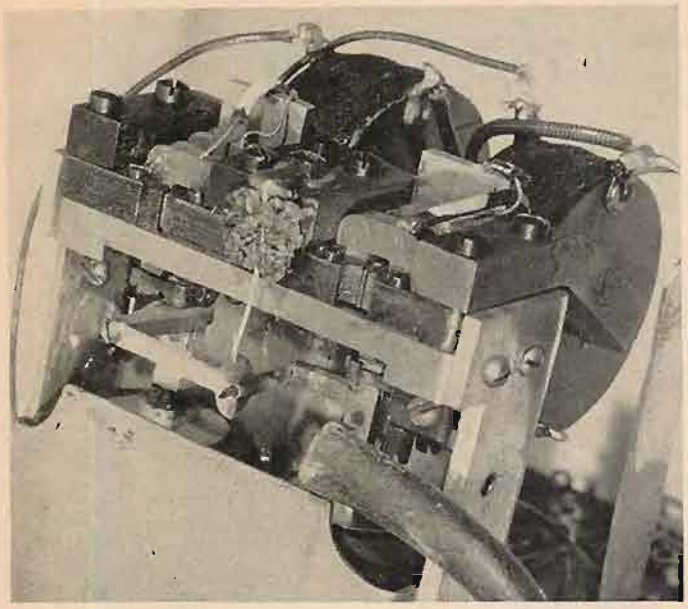


Fig. 2. Blumlein's 1933 experimental 45/45 stere "moving iron" disc cutter. (Photo courtesy Dr. G. F. Dutton, EMI, Ltd.)

cal trick! Your author has a tape dub from a Columbia record, made in 1915, reproduced on a machine of that era, whereon just prior to the music, a voice states:

"The music of Columbia Double Disc records is the music itself, not merely our idea of what we can make the people think music ought to be. You are assured of as perfect a record on each side of the disc as you ever bought before under any name at any price. Perfect in surface, perfect in tone, and extraordinary in durability, the Columbia process of recording produces a naturalness and roundness and perfection of tone that is positively unequaled in any other. The singer's voice as recorded in the Columbia Laboratory is the living voice of the artist: clear, flawless, and natural. And from the simple brassy notes of the bugle to the delicate tone shading of the violin, Columbia recording of instrumental music is marvelously true.—And now the splendid ensemble of the full orchestra."

Despite such statements of finality from sales departments, engineers as a rule tend to ignore them. Engineers are naturally curious, and keep disproving such statements—and then propounding other statements just as final. For example, J. P. Maxfield and H. C. Harrison, of Western Electric, in an article [2] published in 1926, dismissed the dual channel or binaural method as impractical. In its place, they advocated another technique, using two microphones to achieve an "artificial effect of placement." That same year, Mr. Maxfield was loaned by Western Electric to the Victor Talking Machine Co. where he organized and headed the Research and Engineering Department. This was the beginning of the scientific approach to recording, displacing the empirical methods which had been in use since Edison's time. Later, in 1929, Maxfield joined ERPI (Electrical Research Products, Inc., a subsidiary of W. E.) where he made important contributions to electrical recording of sound in perspective for motion pictures.

Since dual-channel recording was "impractical," the "Maxfield pick-up," using two microphones feeding a single channel, came into use for recording and broadcasting. For orchestral pickup, one nondirectional mike was placed out in the auditorium at a point where the sound intensity of the direct sound was approximately equal to the intensity of the reverberant sound. The other, or accent, mike was placed close to the orchestra. This one preferably had a unidirectional response pattern and was used to pick up the weaker instrument sounds while minimizing the reverberant pick-up. Mathematical formulae were developed to calculate the correct positioning of the mikes in the room. This technique was used with great success on the Telephone Hour radio broadcasts during the 1940's.[3]

By 1930, both the people at Bell Labs in this country and of Electric and Musical Industries, Ltd. (EMI) in England were deep in work leading to stereo sound reproduction.

In the U.S., this work led to the sound of the Philadelphia Orchestra playing in the Academy of Music, Philadelphia, being transmitted over three separate telephone circuits and being reproduced in auditory perspective at Constitution Hall, Washington, D.C. This was in April, 1933. More will be said about this later.

And in England, on December 14, 1931, A. D. Blumlein, of EMI, filed for patent on the 45/45 disc cutter and reproducer. This patent (number 394325), twenty-two pages long, was issued June 14, 1933. The cutter could engrave either 45/45 or hill-and-dale/lateral grooves depending on how the associated circuitry was connected. Dr. G. F. Dutton, of EMI, has kindly furnished the pictures (*Figs.* 2, 3) of Blumlein's 1933 experimental "moving iron" cutter and the pickup used to play the resulting records. Dr. Dutton tells[4] what happened next.

"The reproduction quality in these early days was limited by the surface noise of the shellac pressing, and by the tracing distortion due to the large reproducing stylus. The frequency range was limited both by the cutter and the reproducer heads, and it was very soon found that reproduction quality could not be sacrificed in noise, distortion, or frequency range in order to obtain a stereo system. In other words, a stereo reproduction can only be effective if each channel is operating under very-high-quality conditions. The stereo disc therefore was shelved pending the development and improvement of the gramophone technique."

The Bell Labs series of experiments, culminating in the Philadelphia-Washington transmission on April 27, 1933, has become classic. These experiments were reported in five articles published in the Bell Laboratories Record during 1933 and 1934. They were later reprinted[5] by AUDIO in 1957 because of the great public interest in stereo which had by that time developed.

Dr. Leopold Stokowski, Director of the Philadelphia Orchestra, had been interested in the possibilities of electrical systems for the production of exceptional

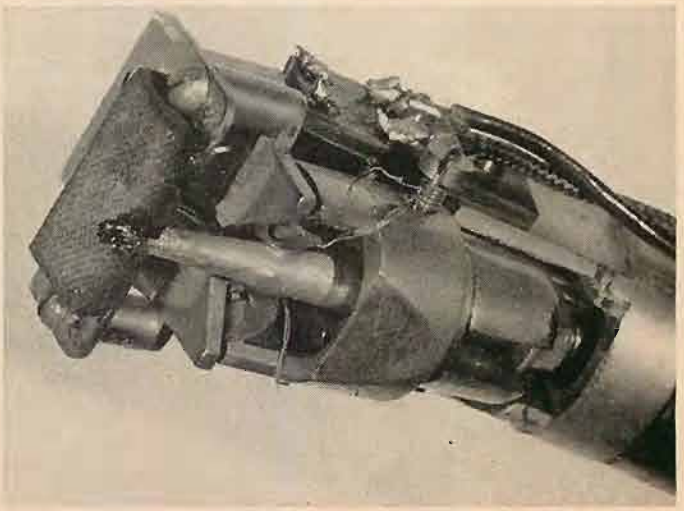


Fig. 3. Blumlein's 1933 experimental 45/45 stereo disc pickup. It worked but was ahead of its time in relation to the recording techniques then used. (Photo courtesy Dr. G. F. Dutton, EMI, Ltd.)

orchestral effects. This stimulus, plus the researches of BTL engineers, brought forth the historic three-channel system used in the Philadelphia-Washington event which included everything from microphones to loudspeakers. Even today, almost 30 years later, the characteristics of this system are enviable. Let's look at the requirements for such a situation. The modern symphony orchestra puts out a dynamic range of 70 db from *ppp* to *fff*. It generates frequencies from 35 to 16000 cps. Its sound power, integrated over 0.2 sec., is 20 watts. This 1933 transmission system, over-all from microphone, through a score of telephone repeaters, power amplifier and out of the loudspeakers, had a signal-to-noise ratio of better than 80 db: silent passages were silent; no hum or hiss. It had an over-all *acoustically* equalized frequency response from 35 to 16000 cps: the instruments sounded natural, without frequency distortion. And it had an acoustic power-handling capability of 20 watts: a bang on the tympani didn't fall apart upon reproduction. The illusion was said to have been astonishingly natural and lifelike. But this event was an instantaneous reproduction of sound. Recordings with such faithfulness, be they tape or disc, are still not commercially possible.

At the conclusion of World War II, German tape recorders found their way to this country via J. Herbert Orr of Irish Tape fame, Jack Mullen, now of Mincom, and the late Col. Richard Ranger. In 1945, Joe Begun, of the Brush Development Co., brought forth the first commercial tape machine in the U. S., the "Sound Mirror." In 1946, Marvin Camras at Armour Research Foundation, who already had several armloads of patents in the magnetic recording field, labored in the chem lab for a month gradually accumulating a pound of iron oxide. He sent it to Minnesota Mining and Manufacturing Co. asking them to coat it on some ¼-in. wide strips of tape. He felt this oxide coating would be an improvement over the few German samples and others that were then available. Camras said to be careful of that pound of oxide, it was all he had, and it had taken a month to make it. 3M wrote back saying they'd be glad to do the coating job, and asked him whether in his experiments he could use more oxide like the sample if they were to send him some. He replied in the affirmative. A day or so later, a 100-pound bag of the stuff was delivered to an astonished Camras. Your author learned later (1950) how 3M chemists produced so much so rapidly. It seems that 3M used iron oxide to color the mix for composition roof shingles, one of their big products. They'd made a batch of coloring that was off-color and couldn't be used in producing shingles. Many sacks of this lay for years in a warehouse. Somebody remembered it, checked it chemically, and discovered that it was similar to Camras' precious pound. Since then, your author has often speculated on whether there may be a correlation between the saving of these unusable bags of iron and the "Scotch Brand" name on the tape subsequently made therefrom.

In 1946, Armour Research Foundation, Chicago, had a two-track tape recorder which, under Marvin Camras' direction, was used particularly for binaural recording, although they also tried stereo reproduction with speakers. Camras, in a recent letter to the author, goes on to say:

"We were impressed with the fact that in listening to our binaural recordings one could pick out the wanted sound and reject the undesired voices, reverberations, etc. We made known our results to licensees, and about this time Ray Zenner wrote an article expounding the merits of binaural recording. A paper entitled a 'Binaural Magnetic Recorder' was presented at the Acoustical Society of America meeting in New York in May, 1947.

"In 1947 I constructed a deluxe version, a three-channel outfit on half-inch tape (actually 6 channels, 3 each way). Western Electric 639-B Cardioid Microphones were used for pick-up. We took this one to many musical events ranging from the dance combo at Arthur Murray's Chicago Studio, to the IIT Dramatic Society.

"The Chicago Musical College became interested in our work, and allowed us to experiment with microphone and speaker arrangements in several kinds of room environments during rehearsals. When we had collected a sufficient variety of good recordings we sponsored a 'debut' in a downtown hotel, jointly with the Chicago Musical College, ARF, and IIT, where we introduced stereophonic tape music to the public. Our program included orchestral music (Prokoffief's "Classical Symphony"), vocal selections from Gershwin, and choral music. We got some nice write-ups in the press, but since no equipment was available on the market, there was not much that the average hi-fi listener could do about it.

"We tried to interest recording companies such as RCA and Columbia, suggesting that the efforts of people like Toscanini ought to be preserved on multichannel stereo master tapes for future possibilities even though they seemed rather remote at the time. As far as I know, nothing was ever done. (I'll bet they are now kicking themselves about that one.)

"In 1948 and for many years afterwards our stereo program was in great demand and was demonstrated all over the USA, mostly before technical societies such as the IRE, AIEE, SMPTE, Sigma Xi, etc. It was written up in *Electronics* (August, 1948), *Tele-Tech (Electronic Industries)* (July, 1949), and *Proceedings of the IRE* (April, 1949).

"In the course of our travels we used the equipment for recording whenever the opportunity presented itself. Particularly during May of 1948, at NBC in Hollywood, we set it up on a handtruck and wheeled it from studio to studio picking up rehearsals such as the Lucky Strike Hit Parade, and the NBC orchestra. The musicians were especially impressed with binaural playback. One conductor remarked that (impossible as it might seem) the reproduced sound was even more pleasant than direct listening. We got permission from the musicians union and other authorities to do the experimental recordings, but just to make sure that we would not use them, they had a couple of 'jokers' stationed near the microphones who made audible remarks at intervals, many of which were 'unprintable'."

The author, at that time connected with Magnecord, had been selling wire and tape recorders (single channel) since 1947 to Chrysler, General Motors, and various air-intake silencer and muffler manufacturers for recording the noises of automobiles at their proving grounds. These uses, supposedly, would make it easier to analyze the sounds in the peace and quiet of the lab rather than while bounding around in the back seat during a wild ride over rough road. Then one day in the summer of 1950, Larry Ball, Director of Acoustical Engineering for Chrysler, phoned an invitation to be his guest at a Society of Automotive Engineers' meeting in French Lick, Indiana. He thought it would be a good opportunity to meet many more potential customers in the automotive field. He said, as added inducement, that the Ethyl Corporation (gasoline additive) cocktail hour was worth attending if nothing else. (It was; they had mountains of shrimp, gallons of sauce, hundreds of toothpicks—and various liquids.)

A symposium on noise reduction in automobiles was held one warm summer morning of the convention. About forty men from the various facets of the automotive industry were seated in a circle outside under the trees. They represented tire manufacturers, muffler people, body builders (auto), and automobile acousticians. The cicadas were buzzing in the trees. Wind noises, cooling-fan noises, tire whine, and methods of reducing these, were discussed. Then the trap was sprung.

Dave Apps of General Motors turned to your author and said, "We've been buying recorders from you for some time now and using them to record all of these noises for analysis. Now, tell me, why is it that when we record the noise made by an automobile being driven over a cobblestone road, and then reproduce it in the lab over the finest quality speaker we can get, it doesn't sound like a car going over cobblestones. It sounds like pebbles rattling in an old tin can."

So that was the reason for the invitation to attend. Then several others complained about how unnatural the various noises sounded when reproduced, but how good music sounded when made on the same machine. For a moment this was a stopper, and time for thought was

requested. Why, indeed? In digging back through the memory, the Philadelphia-Washington sound transmission came to mind. And experiments with having a secretary transcribe (very successfully) a heated conference replete with more than one person talking at a time from a binaural recording. Could it be that we hear what we want to hear because our brains are able to pick out what we wish to hear and reject or minimize all other interference—but only if we have an input to the brain from both ears at the same time? If this is true, the human thus has a natural built-in discriminator.

A few minutes later, Larry Ball (Chrysler) said, "Well, what's the answer?"

A very short time course in the theory and practice of binaural listening followed, with a recall of Camras' two-track machine. Could Magnecord build such a machine? It could, and did. General Motors later tried it out.[6] Then Magnecord made several more for that industry. The heads were "staggered," using two half-track heads, one for the inner track, one for the outer, in two separate head boxes. This was the quickest way to build such a machine without crosstalk. This later led to another problem: staggered or stacked heads? It would have taken too much time to figure out how to shield one head from the other in the same housing.

Shortly after the delivery of the first few binaural Magnecorders to the automotive industry, the author left that company, later to join Ampex.

During the spring of 1951, Eugene Carrington of Allied Radio Corp., Chicago, who at that time was Director of Educational Sales, took a binaural Magnecorder out to his farm. He recorded all sorts of barnyard noises with a tractor plowing a field nearby and cars running past on the road. Later that summer, he took the apparatus up to Interlochen, Michigan, to Dr. Joseph Maddy's Summer Music Camp where he recorded the orchestra and other groups binaurally. He confirmed the findings of earlier researchers that for binaural listening (headphones over the ears) the microphones, spaced the ear distance apart, yielded the best results. This ear-spaced technique was later to trap many who wished to listen over loudspeakers.

Shortly after Gene Carrington returned from Interlochen, he stopped the writer while he was strolling through the Allied store. Gene's activities had been secret up to then. "Want you to hear something—recordings from Interlochen."

He had a recorder, an array of switches, and headphones. Since customers might be disturbed by a loudspeaker in the store area, he was using headphones. The recording was a good (monaural) pickup. Then, in 10 or 15 seconds, he flipped a switch. A shiver ran up the writer's back, and the fuzz on his bald head felt as though it was curling. He'd flipped from one track feeding both phones to the two separate tracks feeding the separate phones. For all of his theoretical knowledge, he had never really had an opportunity to hear such a recording before.

Magnecord gave countless demonstrations of Carrington's recordings at many trade shows during the next year. Then Ched Smiley of Livingston Electronics, New Jersey, picked up the challenge and made the first two-track (staggered) commercially available binaural releases on tape. Some of the more affluent citizens of the land responded by purchasing both machines and tapes. But the going was rough, the musical groups weren't equivalent to orchestras led by Toscanini, and there weren't too many affluent music lovers.

Emory Cook, of Stamford, Connecticut, shortly thereafter marketed 12-inch diameter microgroove stereo discs recorded at 33⅓ rpm. This was not the single-groove complex system as now used and as first done by Blumlein of England, but a two-channel system with one channel recorded on the outer half of the disc and the other concentrically recorded on the inner half. The two pickup heads were mounted several inches apart on a common arm and employed a micrometer screw adjustment between them. The handling of the pickup system was somewhat tricky, and this, with the short playing time of 12 minutes, left much to be desired, although the musical results were good.

The technique of using microphones spaced six inches apart employed by Magnecord at that time, and of reproducing the results over two widely spaced speakers led to some ludicrous results during demonstrations. For example, take the case with the two mikes spaced thusly in the center of a stage and the two loudspeakers used to reproduce the resultant recording spaced near the two sides of the stage. Whenever a person moved slowly from one side to the other in front of the two mikes, upon playback he would seem instead to leap from one side of the stage to the other.

To gain experience, the author, by then with Ampex, took a Model 400 recorder with two-track, in-line heads to the University of Illinois, his alma mater. A week was spent recording both the University Symphony and the Illinois Band. Incidentally, John Philip Sousa left his entire library to this band. Various microphone types, both directional and non-directional, and various spacings, close and spread, near and far, were tried, including a two-channel or stereophonic "Maxfield (double mike) pick-up." Various reproducing speaker arrangements were likewise tried in the large halls where the recordings were made and in small rooms. The early work (1932–33) of Bell Labs was recalled again. The school song, *Hail to the Orange,* sung by the band (!) played an unexpected role a few years later.

Dr. Wolfgang Kuhn (now at Stanford University) the professor of music who was head of musical recording for University of Illinois, and others on the school faculty aided in the experiments and criticized the results musically. The most interesting result was an invitation to return a couple of months later to record stereophonically (not binaurally) the University Symphony and Chorus under Dr. Leopold Stokowski as guest conductor. Upon being introduced to the great man in the hotel lobby and learning that we were from Chicago, he asked, "Do you have your guns with you?"

As the concert was to be released monaurally over the nationwide NBC network at a later date, the university sound engineers as well as the writer's crew (himself) were busy prior to the first rehearsal stringing cables and setting up to make both monaural and stereo tapes. Magnecord had asked permission to record the concert, which the university gave them. Dr. Stokowski had graciously said he would stop at any point during the rehearsal that we wished and repeat sections, or hold until we were ready. He knew the recording problems; he'd been making Victor records since before 1915. We were delighted with his offer of cooperation.

The monaural tapes for broadcast were to be made during the dress rehearsal, the stereo tapes during the actual performance.

But when Stokowski conducts, he immerses himself in the music and forgets all else around him. The crew making the monaural recording missed a cue at one point; Stoky got going before the recorder did and he kept going while the mixer engineer in the side balcony waved frantically for him to stop, per agreement. But the music went on. It was suggested that the mixer might attract Stokowski's attention by whistling. After all, it was a rehearsal and the recording was no good without a clean start. So with fingers in mouth, a piercing "screeeee" cut through the auditorium. Stokowski froze with his baton midway through an upbeat, then collapsed backwards in a slump on his high stool. He put his face in his hands for a few moments, then turned to the balcony and said in a very clear voice, "I told you to stop me, but did you have to be so violent about it?"

The recording experiments in stereo done at this time were reported in this journal[7] at the time and served as the

Fig. 4. Byrns Orchestra binaural recording session, 1952, for Capitol records. Note the "blockhead" with two mikes on the left. (Photo courtesy Ed Uecke, Capitol Records).

basis for the three-track demonstrations at the West Coast Audio Fair in Los Angeles in February, 1953. Through the cooperation of E. H. Uecke, Director of Development Engineering for Capitol Records, a three-track demonstration tape was made up consisting of the Southern Pacific train coming into, stopping, and leaving the Glendale station; Lawrence Welk's orchestra playing its theme song; the Santa Monica Symphony, and George Wright on the Wurlitzer pipe organ.

Ed Uecke has this to say about those days almost 10 years ago:

"In inquiring into our early history of stereophonic recording, I find that we really came in by the back door. Originally we experimented with a two track recorder for 'binaural' reproduction using headphones and made several experimental recordings in 1952. I am enclosing two (2) photographs (*Figs.* 4 and 5) of a session done on April 25, 1952 showing an orchestra conducted by Harold Byrns. You will note the influence of the U. S. Naval Electronic Laboratories research using two (2) microphones spaced at the ears would be in a human head with hatter's block to simulate the head. The demonstration of localization using headphones was spectacular and we were all quite thrilled. Because of the way in which stereophonic reproduction had been handled in motion pictures, there was a strong inference that three-track recording would be necessary or at least highly desirable for loudspeaker reproduction. You may remember that there was a three-track ¼-in. Ampex tape machine which made its appearance in Los Angeles and I believe that Santa Monica Symphony recording was done with this equipment. Anyway, it was not until August of 1952 that we obtained a satisfactory proposal from Ampex to construct a ½-in. three-track tape machine. This was delivered to us on January 6th of 1953 but was not immediately used for stereophonic recording. Its first application was to record vocal, chorus, and orchestras at the original session which was later to be mixed to obtain the best balance of sound for a monophonic record. One of our first sessions was with Gordon McRae done on January 19, 1953, and a few days later we made the now famous Lawrence Welk three-track stereophonic recording which was re-recorded to three-track ¼-in. tape and used at the February, 1953, AES Convention. According to Bill Cara, who was the convention manager that year we had an attendance of 13,000 people at the demonstration February 5th, 6th, and 7th."

Among those 13,000 people, as one might expect, were several from various motion picture studios. Wide screen "CinemaScope" was about to be released in an effort to stimulate an industry beset by competition from home TV. Although much work had been done from time to time with multi-track optical film recording since the late twenties, culminating with the Disney road show release of "Fantasia" in the late thirties, it took this demonstration of three-track magnetic tape to convince Hollywood that magnetic sound tracks on film, instead of optical, might be practical for general theater release. "Cinerama," using seven magnetic channels on a separate film synchronously locked to the picture film, was then being shown in only two or three specially equipped houses in the country. It should be noted that Camras had shown magnetically striped film in 1947 to the SMPTE. So the first releases of "CinemaScope" were made with four magnetic stripes on the film, two on each side of the sprocket holes on each side of the film. Three stripes were wide and used for the three speaker channels behind the screen. The fourth was narrow and used for the "surround" speakers out in the auditorium to create special effects.

A few months after the 1953 Audio Fair demonstration, a phone call from Hollywood inquired as to whether Ampex was interested in providing some special recording equipment for a Mr. Anderson. Possibly. He would be up to visit the plant. Mr. Anderson and several others showed a few days later. When they were sure that the plant was interested, had the capability, and that no one could overhear the conference, Mr. "Anderson" was reintroduced as Michael Todd. Under the direction of Walter Selsted, formerly with Ampex as Director of Research, the company built a special 7-track system for him. This was the start of the Todd-AO system.

Pentron, in late 1953, built a 6-track machine, their "electronic orchestra," wherein six different orchestral instruments were recorded, one to a track. Six speakers were arranged physically in the room and the six musical instruments would normally be arranged. The jazz

Fig. 5. Closeup of the "tailors dummy" shown in Fig. 4.

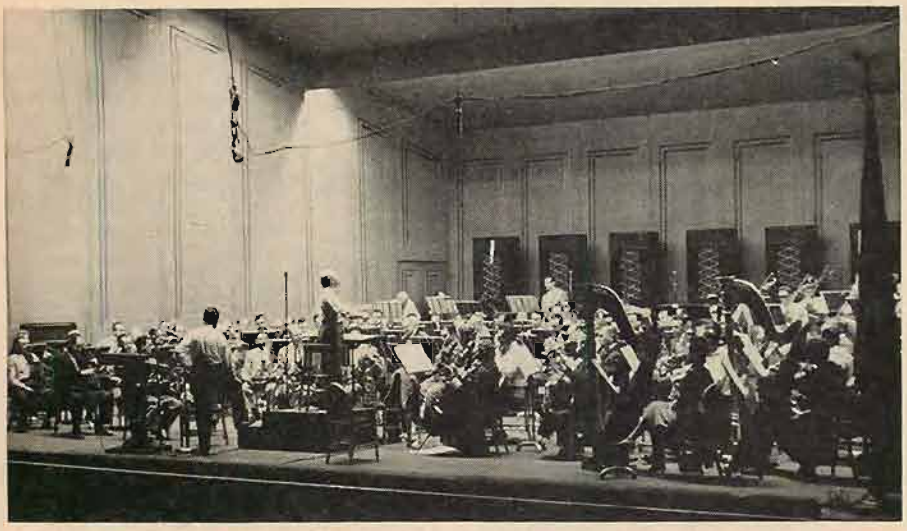


Fig. 6. Rehearsal for "Soundorama" stereo recording concert of the Philadelphia Orchestra, February, 1956, Eugene Ormandy conducting. Note two-channel stereo mike placement. The center mike was used for monophonic "protection" recording. The loudspeakers were later shifted to center of orchestra in two groups of three each, middle right and left, for better stereo reproduction in hall. **(Photo courtesy Sound Recording magazine. Adrian Siegal, photographer.)**

reproduced was natural and stimulating at several hi-fi shows.

In 1954, John Leslie, formerly with Ampex as Chief Engineer for Professional Recorders, and the author, formerly Marketing Manager for the same, decided to see what might be done to build an inexpensive two-track playback tape machine, one which might possibly fit the home pocketbook. A regular professional two-track stereo recorder carried a price tag of better than $2000.00. It was figured that many people who bought tape recorders used them at first to make recordings, but soon used them only for playing the tapes they'd made and only occasionally thereafter used the recorder as a recorder. By this time, a compact extended-range speaker-amplifier had been placed in production and a small tape deck, the Model 600, was available. All that was needed was a two-track playback-only amplifier to feed two speakers, plus an inexpensive (!) two-track in-line head. We had to repackage the 600 and multiply it by two. The inexpensive two-track in-line head caused some problems. Although the project wasn't exactly authorized, management was forgiving when they heard the system as it played *Hail to the Orange* by the Illinois Band, and the Symphony Orchestra stereo tapes recorded in 1952. Arthur Fiedler of the Boston Pops Orchestra, who conducts the San Francisco Orchestra during the summer season, was the first outsider to hear the new system. He was tremendously impressed, and felt that this was the next big step in home music. But all concerned recognized that it would take one of the big recording companies to push this technique into the home.

Very quietly and without any fanfare, one of the companies had been making some stereo masters experimentally. W. H. (Bill) Miltenburg of RCA Victor, a short time later to become its director of Recording, recalls those events.

"Al Pulley (of RCA) and I made the decision to record stereophonically on a trial basis in 1954. The first stereo recordings produced by RCA Victor were made using a pair of converted RCA-RT11 recorders (*Fig.* 8) equipped with handmade heads. Our first (test) was in New York City, then to Chicago where 'Also Sprach Zarathustra' and 'Ein Heldenleben' were recorded, with Dr. Fritz Reiner conducting. ((These)) subsequently became the first stereo releases for Victor. The decision to record all masters, using the three-track technique ((instead of the original two-track, as in the first experiments)) was mine."

Dr. Dutton reports that in April, 1955, EMI first marketed stereosonic tapes in England for a home user. (Note the English spelling.) These were two-track, 7½ ips, as were RCA Victor's first releases. And for some time the English releases far exceeded those in the U. S. in number, but they were difficult to obtain on the west side of the Atlantic.

That same fall (1955), the writer made a tour of the major recording companies in this country showing them the two-track playback tape unit which Arthur Fiedler had heard. A demonstration tape had been assembled from a great number of tape dubs from old records, starting with the sounds of 1899 and progressing up through the years to the LP disc—all played through only one of the two speakers, of course. Then a tape master of the LP just played (with no "ticks and pops") was followed by a spine-tingling passage from RCA Victor's new stereo release, "Zarathustra."

The reception of this demonstration by the professionals was mixed. Some were impressed with the commercial possibilities. One saw the "battle of the speeds" all over again between discs (monophonic at that time) and tape (stereo). They weren't about to kill themselves financially again as they almost had with 78-*vs.*-45-*vs.*-33⅓ which had been pushed at a confused public who didn't know what to buy. And some of them, on hearing the stereo tape, just plain denied that stereo was physically possible, even after hearing it!

But Livingston Electronics and RCA Victor kept putting out an occasional stereo tape. VM Corporation made stereo conversions for their tape recorders in 1955 so that people could hear the new tapes. The "staggered" *vs.* "stacked" head configuration became the issue, with the obviously better solution ("stacked") finally winning out.

Bill Miltenburg reports on the next steps taken by Victor.

"Ampex produced four ½-inch tape triple-track units in 1956 for RCA Victor. At the time of the order it was my impression they were the first of this type produced by Ampex and I believe you were deeply involved in these discussions. Two of these machines were delivered to Republic Studios in Hollywood for use on the Jascha Heifetz sessions with the Hollywood Studio orchestra. You may recall the urgency of the situation, and the subsequent arrival of two of your engineers to attempt the alignment and re-checkout of the machines. Because of the ((basic)) misalignment of the gaps in the heads, the re-recording of these masters had to be performed on the machines upon which they had been recorded."

. . . " As far as I can ascertain, the stereo disc idea in the United States was mine. This is difficult to pin down because many people have claimed they were working on the project during this period. However, the record speaks for itself; we did contact Westrex in 1954. To say that they were less than enthusiastic is the understatement of the year. They finally agreed to consider the idea, although they cautioned me not to expect too much. Of course RCAV management gave me little encouragement.

"About a year later, after a number of telephone calls, letters, etc., I decided to set up a meeting in Hollywood to determine if Westrex had any interest in the project. This meeting was held in 1955 with Messrs. Wyte, Frayne, Davis, and myself, at the Westrex offices. In the interim I had contacted Ed Uecke of Capitol, and learned he was also pushing Westrex. Due to the urgency and pressure, plus a guarantee, they began work on the project. We decided on the 45/45 approach after many discussions, trials, errors, etc. We also ruled out the vertical/lateral method because of the vast amount of experience we all had with that method during the early motion picture days. During this period I learned A. Haddy of London Decca was experimenting with the vertical/lateral system; this was later substantiated.

"RCAV began production of two-track prerecorded tapes in the latter part of 1955. We were also working on the cartridge during this period. I believe RCAV

released their first cartridges during 1958. They are still producing cartridges."

In an effort to show the public what stereo tape could do, two important major demonstrations took place in 1956: one in Philadelphia on February 13, and one in San Francisco in early March.

Eugene Ormandy, conductor of the Philadelphia Orchestra, invited M. Robert Rogers, president of WGMS, Washington, D. C., to produce "Soundorama." Billed as a High Fidelity Concert and Recording Session put on to aid the orchestra's pension fund, Mr. Rogers invited three companies (Ampex, Fisher Radio, and Jensen Manufacturing Co.) to participate with their equipment. On-the-spot two-channel stereo recordings were to be made and reproduced immediately thereafter over speakers mounted on the stage to show how faithfully the full sound of the orchestra could be reproduced with modern recording and reproducing equipment. This concert was the best attended of any during the entire Philadelphia season. The program consisted of Britten's "Grownup's Guide to the Orchestra;" Rimsky-Korsakov's "Capriccio Espagnol;" Bach's "Toccata and Fugue in D Minor"; and Strauss' "Dance of the Seven Veils."

About the "Caprice," said Rogers, who acted as commentator, "Here is a Spanish number with an Italian title written by a Russian and played by an American orchestra."

The Fugue portion of the Bach had previously been recorded during rehearsal. During the concert, the orchestra played the Toccata and were to fake the playing of the Fugue as it started, with the previously recorded section segued in at the start of it. Those of us responsible for riding gain and pushing the start button on the recorder had a few anxious moments, hoping nobody had diddled the level, that the equipment would go when it was supposed to, and that the orchestra would be able to catch the cue. Ormandy, always a delight to work with, led into the Fugue and kept on conducting. The start button was pushed and the music came out. In about ten bars, the orchestra quit faking and laid down their instruments. The music kept playing. The audience responded generously, and the engineers relaxed to listen, too.

The following month, with the cooperation of Enrique Jorda and the San Francisco Symphony Orchestra, Walter Selsted headed a team that used a three-track machine, using ½-in. tape running at 30 ips, to put over the best piece of fakery ever.[8] Three Altec 22D microphones were used. Three Altec theater speaker systems were buried—almost out of sight—in the midst of the orchestra. During rehearsals a sound-level meter was used in several parts of the hall to set the speaker acoustic level to match that of the orchestra. The acoustic frequency response of the system was carefully checked and appropriate equalizers were inserted to correct the over-all response to better than 12,000 cps. The usual tape hiss often noticeable on other systems was inaudible to all save those in the first few front rows, largely because of the optimum equalization possible at 30 ips.

The hall was virtually a sellout and again the best attended performance of the entire symphony season. Dr. Jorda stepped out of the wings and onto the podium. The baton was raised. The tape machine, mounted in a rack, right stage in full view of the audience, was started as though to record the performance. On the down beat, the orchestra commenced playing. They played for several minutes. Then the concert master got tired of playing and stretched. One by one, the members of the orchestra quit or stood up. Jorda quit conducting, but the music kept playing. The segue from orchestra to tape was undetectable. It was so undetectable that a special announcement had to be made after the intermission because of the confusion. The orchestra hadn't really played at any time at all during the first number. It had all been faked. The comments overheard in the lobby after the concert indicated that even after the explanation some people still believed that the orchestra really had been playing part of the time.

Just before the intermission, several individual groups of musicians remained on stage. The trumpet player alternately tried to out-play the loudspeaker rendition of the successively more difficult variations on the "Carnival of Venice"—every other one of which he'd previously recorded for the purpose. The bassoon player played one part which was recorded, then played a duet with himself. Finally, the entire percussion section played several tricky bars. The tape came back with an even more tricky reproduction, previously recorded, of course. Not to be outdone, the members really slammed the skins and beat the cymbals. The tape was set in motion, but no sound issued from the speakers. The tape was rewound and the live group tried to be recorded once again. The din was tremendous—actually far beyond the capability of the system's dynamics. The tape was again set in motion, but no sound came from the speakers. Suddenly, from each of the three speakers on the now virtually deserted stage, there issued a flash of fire and large billows of black smoke (old-fashioned photographic flash powder). The little old lady, a steady symphony patron, sitting next to the author's wife, said, "Oh, dear, that's a shame. All that expensive equipment! And I was so enjoying it all."

Later that summer, the author participated in a variety of listening tests in an effort to see what might be done toward housing both speakers of a stereo system in a single cabinet, together with radio, record changer, and tape recorder. We wanted one which might be acceptable from a size standpoint in anybody's living room. The original prototype then had two modified Model 620 speaker-amplifier assemblies hidden behind the grille cloth. Our listening tests finally led us to splaying the axes of the speakers 12 deg. from the centerline and cocked up from the horizontal about the same amount.

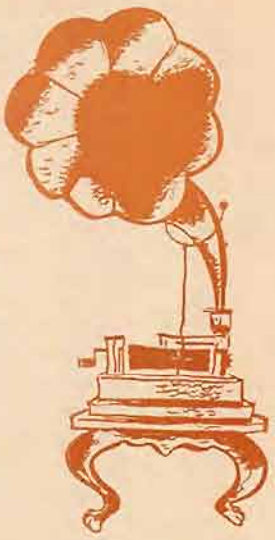
Recording two parallel tracks on tape was by now a simple accepted process. But tape machines compared to disc phonographs were expensive and awkward to thread and use. The public was

(*Continued on page 91*)

Fig. 7. RCA Victor's first two-track stereo recorders, Model RT-11, with "home-made" two-track in-line heads for ¼-in. tape. These were used in 1954 to record "Zarathustra" performed by Chicago Symphony Orchestra, Fritz Reiner conducting. **(Photo courtesy Bill Miltenburg.)**

AUDIO PIONEERS

OF THE PEOPLE AND BY THE PEOPLE



Webster defines a pioneer as "one who goes before, as into a wilderness, preparing the way for others to follow." Here are some of the people who went before in audio.

Ben Bauer

I clearly remember how it all started: At the age of 4 or 5 some inexplicable demon compelled me to stick a bent wire into a power outlet. The resulting flash-bang was my first contact with electro-acoustic transduction!

My formal entry into electroacoustics was much less traumatic but no less accidental. As a student at the University of Cincinnati during the depression, I heard of a co-op job in Chicago. The pay was to be 40¢ per hour but during those days we would have travelled to the ends of the earth for a job! The type of work? Developing microphones and pickups. No one knew too much about these products and the market for them was extremely limited. I asked Ralph Glover, at present Vice President of Jensen, but at the time Chief Engineer of Shure Brothers, how long he expected the market for microphones to last. "Five years" was the reply, and this was good enough for me. Then Wilcox Gay came out with disc home recording in 1938 and we were off to the races with microphones, pick-ups, and magnetic record cutters which found their way into hundreds of thousands of homes in America. This taught me never to underestimate the capacity of the American public to accept complex technological advances where these served an important physical or emotional need. Being able to hear one's own voice and saving for posterity the voices of dear ones definitely served such a need.

Without a doubt the late thirties were the formative years of high fidelity, and the field was fertile for improvements. We spent innumerable days pondering about the optimum shape for tone arms, for example, and I even proposed a scheme for curing tracking error by offsetting the stylus in a certain manner. This scheme got into production but subsequently was found to be illusory! Later I expiated this youthful error by developing the currently accepted theory for arm design and placement for minimizing tracking error. The experience, however, taught me not to jump into production with anything without being certain of its technological merit. Haven't we witnessed during the past years the advent and oblivion of several phonograph arms which purported to further reduce tracking error, but at the cost of mechanical complexity and other disadvantages?

During these formative years many of us became greatly concerned with the quality of disc recording and reproduction, and especially with the wear of styli and records resulting from the 3–4 oz. stylus forces in then existing phonographs. We spent considerable effort in reducing these forces to below 1 oz. Then in 1938, a relatively unknown Harvard professor briefly caused a stir with his 2-gram pickup but he was too far ahead of his time to be labeled anything but a visionary. Since that time, Frederick V. (Ted) Hunt has been one of my favorite prophets and his theoretical work on groove-stylus relationships with Pierce, Lewis, and Miller has been the foundation of modern high fidelity. The academic people are often years ahead of the

industry, which proves the value of untrammeled research. Just why such a large segment of industry refuses to heed this fact has always remained a mystery.

The war temporarily put an end to all the work and fun with disc recording and reproduction as we went about the grim business of manufacturing military microphones and headphones. But for me the drive to reduce stylus forces had become sort of a predilection. In 1947 I decided that it was time for another round of stylus force reduction and started a small project to develop a high-output pickup that would work at about ⅓ oz. Coincidentally, as this work was being finished Columbia announced the Long Play record! We only had to place a second point on the opposite end of the stylus shank and here was a turnover cartridge ready to be offered to the industry. The trend toward lower forces continued until 1957 when Shure introduced a 1-gram moving-magnet Studio Dynetic pickup. But the garden variety of home phonographs stayed with the 7–10 gram forces until this very day. Finally, a two-gram high fidelity stereophonic pickup-changer combination recently developed at CBS Laboratories is about to be commercially announced. It is interesting to reflect on how the record changer manufacturers traditionally resist the lowering of stylus forces. They always come through, however, when commercial pressure is on.

Just as we have the 1–2 gram stylus force fairly well in hand, Ted Hunt again goes to an order of magnitude lower and speaks of 1/10 gram pickups, I guess we will have to find ways of lowering the needlepoint impedance of the dust which settles on records!

We all indulge in hobbies, and one of mine during the past years has been trying to convert the art of high fidelity into a science. During the thirties there was little in the way of measuring tools available. Any test records that could be obtained were wholly nondescript, and bore no relationship to what actually was to be found on commercial discs. Buchmann and Meyer developed a theory for test record calibrations by light patterns but there were alarming discrepancies between their theory and microscope measurements and the latter were impractical at high frequency. In the forties, I discovered that lack of parallelism of light rays was a cause for the errors and derived a correction formula. However, some inexplicable differences remained which were finally disposed of in the fifties by studying the effects of diffraction and interference of light. Subsequently, it came out that the problem has been tackled before but the previously proposed solution required the use of a special sextant-type instrument and subjective judgment while mine did not. This has reinforced my contention that a review of the literature is not always the best first step in solving a problem.

I am delighted to see that Anderson is continuing this work, having applied the diffraction pattern calibration method to stereophonic test records.

Another interesting interlude was work in connection with the measurements of dynamic characteristics and tracking force of pickups. Previously we have seen solemn-faced engineers trying to appraise the stylus compliance by wiggling the stylus between thumb and forefinger. A resonant compliance meter developed in 1946 is still the accepted method for compliance measurements.

This predilection for improved methods of measurement may have been the principal motivation of our recent introduction of the CBS Laboratories STR 100 record which finally has provided a means for continuous and automatic measurement of pickup characteristics with curve recorders, as well as for an appraisal of hi-fi system performance without elaborate instrumentation. The horizontal and vertical modulation bands for compliance measurements on this record were suggested by George Sioles.

Willy-nilly, we all eventually come to the conclusion that greatest advances in high fidelity are apt to come from better understanding of the mechanism of hearing. This work has been very rewarding. For example, studies of the effects of intensity *vs.* time of sound arrival in stereophonic localization has resulted in a loudspeaker system which allows stereo to be enjoyed equally from a wide listening area, and finally in a proof that under certain conditions sounds can be heard from considerably beyond the confines of loudspeakers. Another result of these studies has produced a symmetrical network which cross-feeds stereophonic channels with appropriate delays and intensity functions from one earphone to another, so that the earphones will create the same auditory effect as when listening to loudspeakers.

Rudy Bozak

R. T. (Rudy) Bozak, whose name appears on what are acknowledged to be among the finest loudspeakers in the world, is an audio pioneer indeed.

Almost since the day he left college in 1932 he has been intimately associated with the effort to improve sound reproduction. In that year he went to work for the Allen-Bradley Company in Milwaukee. His first assignment was in the section developing tone-compensated volume controls in accordance with the newly developed Fletcher-Munson curves —an exciting advance in radio. It soon became apparent that the loudspeakers available were not adequate to test the volume controls, and Rudy Bozak embarked on a career dedicated to loudspeaker development.

In 1936 he became assistant chief engineer of the Cinaudagraph Company, which, at the time, was creating the forerunners of all of today's fine speaker systems. He was promoted to chief engineer in 1938, a position which enabled him to work on some of the most exciting audio projects of the time.

Thorough-going, Rudy reasoned that, if he was to make significant contributions to the reproduction of music, he first must understand the production of fine music. So he devoted several years to work as an engineer with such manufacturers of musical instruments as the C. G. Conn Company and The Rudolph Wurlitzer Co. During those years, he learned much about the little nuances which distinguish great sound from the merely adequate.

Thus, in 1948, when he established his own company to manufacture high fidelity loudspeakers, Rudy Bozak already had 16 years in the audio industry in his backlog of experience.

His first product, a classic in the annals of high fidelity, was introduced through an advertisement in the infant **Audio Engineering** (now **Audio**) magazine in May, 1949. That product was the Model B-201 loudspeaker—a two-way direct radiator system enclosed in a hemispherical infinite baffle. The specifications of that system would do credit to

many home music systems today—response, 40 to 13,000 cps; impedance, 8 ohms; input power, 12 watts. The enclosure might be considered a trifle large in today's living room, however, having been a steel hemisphere 32 inches in diameter.

It is interesting to note that Rudy Bozak from the beginning maintained his belief in the fundamental correctness of the infinite baffle enclosure. During the days when others were experimenting with such complex enclosures as the bass reflex, the folded horn, the Helmholtz resonator and so on, Bozak speakers continued to be housed in infinite baffles.

Since the introduction of that first Model B-201 thirteen years ago, Bozak has continued to hold a leading position in loudspeaker engineering, continually improving performance, and, at the same time, making loudspeakers more and more an accepted part of the home decor by providing smaller enclosures for given performance specifications and by providing those enclosures in a wide variety of fine furniture designs and finishes. Today's Bozak line ranges from the Model B-2000 bookshelf unit (several of which could fit inside the 27-inch woofers Rudy designed for the Lagoon of Nations at the New York Worlds Fair—one of the first public stereo installations) to the Concert Grand, Model 310A, recognized by many as the world's finest speaker system for home music reproduction.

A graduate engineer with a B. S. from the Milwaukee School of Engineering, Mr. Bozak, despite his success in the high fidelity industry, is an unassuming, modest man, known and loved by nearly everyone in that industry. If the term "gentleman" applies to any one audio pioneer more than to others, that man is Rudy Bozak.

Along the way, Bozak has compiled an enviable record of firsts in loudspeaker development—the first variable-density cone and high-compliance linear suspension to provide improved low-frequency transient response; the first peak-free direct-radiating tweeters mounted in arrays for broad dispersion of highs; the first direct-radiating speakers designed especially for the reproduction of mid-range frequencies; the first speaker systems with modular design to permit growth by the addition of speaker elements; the first single-cabinet stereo speakers using doors as sound reflectors; the first fine furniture speaker enclosures with matching cabinets to house electronic components, and the first totally weatherproof high fidelity speakers.

G. A. Briggs

It is with great pleasure that I make my small contribution to the 15th Anniversary of **Audio**. The life of this journal just about agrees with the period of development of hi fi, but I am not going to flatter the publishers by suggesting that they have been solely responsible for the phenomenal growth of interest in the subject.

My own connection with the audio industry began in 1932/3 when I started to make loudspeakers—not because I was an engineer but for the simple reason that I was being ruined by the slump in the rag trade and I had to make a living somehow.

My first model was a monster fitted with a chrome magnet weighing about 5 lbs., giving a flux density of a mere 7000 lines. The same flux density can be achieved today with a magnet weighing only 2¼ ozs.

The only other pre-war development worth mentioning here is the infinite baffle speaker designed by post office engineers in 1938. Fitted with a free edge

cone, resonance 35 cps, this model still performs quite well but is not up to modern standards.

Jumping now to the post-war or hi fi period, the pursuits which have interested me most have been writing semi-technical books and giving concerts of live and recorded music which have brought me into contact with a large number of charming and helpful people, including engineers, musicians and amateurs.

There have been three things in the hi

Partners in Progress —

A 15th Anniversary Salute to AUDIO from Bozak

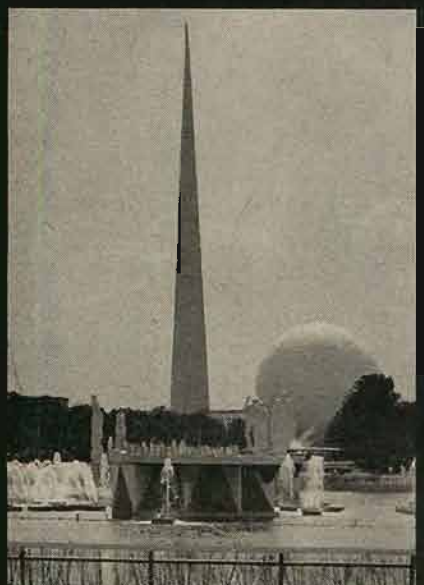
The publication of the first edition of Audio Engineering exactly 15 years ago might well be considered to mark the beginning of high fidelity as an industry. Until that time only a handful of audio pioneers were manufacturing quality sound equipment, and users learned about new developments largely by word of mouth. There was no means of mass communication directed toward families seeking to improve the quality of music in their homes.

Recognizing a rapidly growing interest on the part of the public in better sound, the far-sighted founders of Audio Engineering stepped into the communications gap with their May, 1947, issue—"the first magazine about high fidelity."

From that moment on, high fidelity manufacturers could direct news of their product progress to the readers most interested in high fidelity; at that moment, high fidelity stepped from the laboratory into the living room.

The first Bozak speaker system available to the music loving public was introduced in the pages of the infant Audio Engineering in May, 1949, and Bozak has continued ever since to use Audio to deliver news of its continuing program of loudspeaker improvement to the opinion leaders in the world of high fidelity.

R. T. Bozak, *audio engineer, high fidelity pioneer for three decades and president of The R. T. Bozak Manufacturing Company, manufacturers of the world's finest speaker systems.*



1939 *Then chief engineer for the Cinaudagraph Company, manufacturers of the forerunners of all modern high fidelity speaker systems, R. T. Bozak designed the 27-inch, 250-pound woofers used in the speaker system for the Lagoon of Nations at the New York World's Fair. This was the first public stereo installation.*

1949 *First product of the newly formed Bozak company was the Model B-201, aptly named the "kettle drum" from its 32-inch hemispherical steel infinite baffle enclosure. Its honest frequency response from 40 to 13,000 cycles would do credit to many modern systems.*

1949 *The first fine furniture enclosure by Bozak was this housing for the kettle drum speaker. Its size can be judged from the fact that it contains a 32-inch-diameter hemisphere. Bozak's continuing research and development program today permits equivalent performance from a bookshelf speaker only 14 inches high.*

1953 *Bozak introduced the first single-cabinet stereo speaker system using end doors as sound reflectors.*

May, 1949 *This first advertisement for Bozak loudspeakers appeared in the infant Audio Engineering magazine.*

In the pages of Audio, Bozak has informed knowledgeable audiophiles of such important "firsts" in loudspeaker design as:

—the first variable density cone and high compliance linear suspension to provide improved low frequency transient response.

—the first peak-free, direct radiating tweeters mounted in arrays for broad dispersion of highs.

—the first direct radiating speakers designed especially to reproduce the important mid-range frequencies.

—the first speaker systems with modular design to permit systematic growth and to prevent obsolescence of existing systems.

—the first (and much copied) single-cabinet stereo speakers using end doors as sound reflectors.

—the first fine furniture enclosures with matching cabinets to house electronic components.

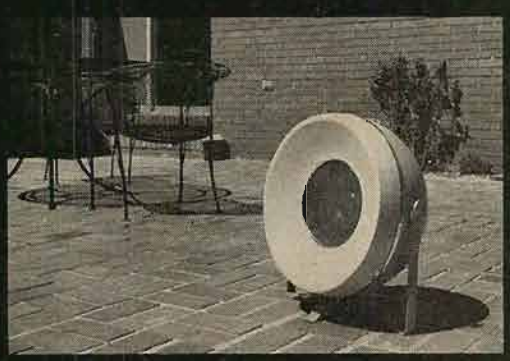
—the first totally weatherproof high fidelity speakers.

—the first panel-mounted speaker systems for built-in installations.

The result has been mutually satisfying — for music listeners, for Audio and for Bozak. Audio continues to grow. Bozak continues its leadership in the loudspeaker industry. Music lovers continue to benefit from genuine improvements in the quality of music in the home.

Audio, for your part in the success of our industry, we at Bozak salute you.

Bozak



1961 *Bozak's early experience with hemispheric baffles permits the development of the Bard — the world's finest outdoor speaker for home music systems — a completely weatherproof unit.*

Careful engineering . . .

Skilled craftsmanship . . .

And complete control of the manufacture of essential speaker parts have enabled Bozak to maintain leadership since the beginning of high fidelity.

Bozak
587 Connecticut Avenue
South Norwalk, Connecticut

fi industry which have always appealed to me. These are: (1) the customer is not always right; (2) it often pays not to advertise; (3) the small man often succeeds where the large company misses the hi fi boat.

The fact that the customer is often wrong was brought home to me 25 years ago, when one of them wrote to say that his speaker was satisfactory on the home service but distorted on foreign stations. We still enjoy ourselves pointing out to customers, in a polite way, when, where, and why they are wrong.

As to advertising, if you are writing books or giving lecture demonstrations, the only way to succeed and to receive help from various quarters is to cut out the advertising of products.

Finally, the small man. There is no doubt that the hi fi market needs personal attention, and I can cite six very large radio and electrical concerns in this country who have dabbled in hi fi and then given it up as a bad job during the last ten years or so, and I would say that the hi fi journals have given excellent support to the little man (in the commercial sense) provided his ideas were sound (in the technical sense).

Anyway, it has suited me to work and play in a field where mass production methods and slogan sales systems can be booted out without stopping the game.

I suppose 1948 was my luckiest year because I then succeeded in borrowing enough money from the bank to enable me to pay my first visit to America, with a little book on Loudspeakers which I had somehow managed to get into print. I had the good fortune to run into Mr. Leonard Carduner, and thus began a valuable association between Idle, Bradford, Yorkshire, and the newly developing hi fi interests of the U.S.A. The lucky part was, of course, the timing; ten years sooner or later would have been comparatively useless.

Then in 1955 and 1956 we gave a couple of lecture/demonstrations in Carnegie Hall, which were rather bold ventures with many pitfalls, but the incident which stands out most clearly in my mind occurred on the day of the first concert when I called at the barber's shop near the Barbizon Plaza Hotel and asked to be smartened up for the occasion. They gave me a blue rinse!

I have been surprised that more live/recorded concerts have not been given in America and Great Britain. After about twenty of such efforts I have retired from the fray, but I believe greater realism could be achieved today with two channels working.

Victor Brociner

Victor Brociner is a native New Yorker and a graduate of Columbia University in Mechanical Engineering (1931). He is a member of the Audio Engineering Society, the Institute of Radio Engineers, the Acoustical Society of America, and the Radio Club of America.

Although his formal training involved specialization in internal combustion engines, Mr. Brociner gravitated into electronics soon after receiving his degree. For a number of years he was concerned with industrial applications of photocells for control and measurement. In 1937 he and two associates formed the Philharmonic Radio Company which pioneered in the high fidelity field, manufacturing a wide-band hi-fi radio-phonograph.

World War II shifted these activities to the field of military electronics. Subsequently, Mr. Brociner formed his own company, marketing a line of high fidelity amplifiers and loudspeakers under his own name until 1957, when he became consultant to a number of firms in hi-fi and industrial electronics. He joined University Loudspeakers, Inc. in March 1958 as full-time Staff Consultant. He became Director of Engineering in the Fall of 1960.

The Philharmonic wide-band radio-phonograph mentioned above was probably the first truly hi-fi instrument commercially produced in this country. It

was designed under Brociner's direction, with William Weeden as consultant. The tuner-amplifier was flat within 3 db from 30 cps to 10,000 cps from antenna to voice coil, on AM (of course) delivered 25 watts of power, with negative feedback over 3 stages. Even at this early date, the speaker system comprised a woofer-tweeter combination, in a closed compartment. A sample of this Philharmonic receiver is now in the Smithsonian Institute, donated by Avery Fisher. After World War II, Brociner pioneered in the design and commercial production of a phonograph preamplifier for the recently introduced magnetic cartridges, offering a wide range of adjustable equalization characteristics. At that time, no standard frequency characteristic had been adopted for recording, and records of different manufacturers sounded quite different when played with fixed playback equalization. The feature of adjustable phono equalization eventually became standard on all hi-fi amplifiers. Since the adoption of RIAA equalization, this feature is gradually disappearing from general use, although it is still retained on the more elaborate amplifiers and retains its utility for those having extensive record collections not all of which were recently acquired.

When the ultra-linear power amplifier circuit was introduced, Brociner immediately recognized its advantages and was the first on the market with an ultra-linear power amplifier, producing it first for Audio Exchange and then as the Brociner Model UL-1.

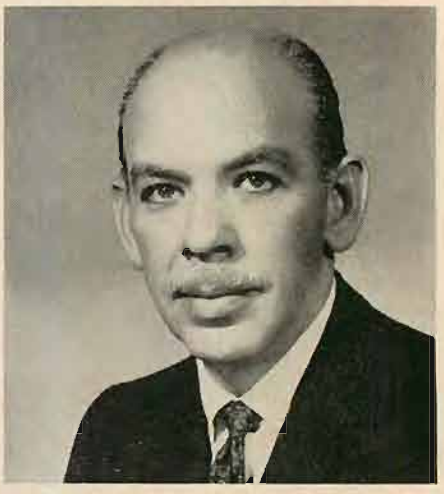
As the hi-fi market developed it became evident that the bulk and cost of equipment required reduction, without any compromise with quality of performance or reliability. The Brociner Mark 12 Integrated Amplifier answered these demands by using etched circuit boards ("printed circuits") in a combined preamplifier-amplifier in a compact package.

In speakers, Brociner was the first to produce commercially a corner horn speaker system licensed under Klipsch patents. Later, he introduced the Model 4 Corner Horn, powered by the remarkable British Lowther PM2 unit that evolved from the early pioneering efforts of P. G. A. H. Voigt. In addition, he marketed a very early version of today's duct-loaded cabinets under the name DUCTFLEX.

Leonard Carduner

Leonard Carduner joined British Industries shortly after its founding (by his brother, William Carduner, in 1937). The company was formed to introduce Garrard record-playing equipment to the U. S. market, and has continued to be the sole American marketing organization.

Before World War II, Garrard was sold largely for use in fine packaged sets. There was little or no consumer market for components, per se. Immediately after the development of the LP record, the Garrard RC-80 was announced and, under Leonard Carduner's direction, the company began its efforts to introduce the concept of a true high fidelity record changer to the hobbyist and to pioneer in the development of a consumer high fidelity market. At the time, there were few distributors taking a serious interest in the possibilities of developing a consumer demand for component music systems. They were reluctant to act as retailers (despite the growing demand), because they feared this might jeopardize their standing as "jobbers." In conjunction with a very small number of manufacturers, Leonard Carduner devoted a great deal of time to personal visits and contacts with distributors, in order to convince them of the existence of the market, and to persuade them to adopt the up-to-date merchandising techniques used by retailers of fine equipment in other industries. His efforts gradually succeeded, and this was reflected by the



acceptance of the Garrard line and the growth of British Industries Corporation.

From this difficult beginning, BIC grew steadily in electronics and other fields, introducing to the American market a variety of excellent British products. These have included Multicore Solder, Gold Lion Tubes (formerly called Genalex Tubes) made by the General Electric Co. of England, Leak Amplifiers, unsurpassed Wharfedale Loudspeakers and books by G. A. Briggs.

Mr. Carduner's contributions to certain milestones in the development of high fidelity have included:

A. A personal campaign of travel and

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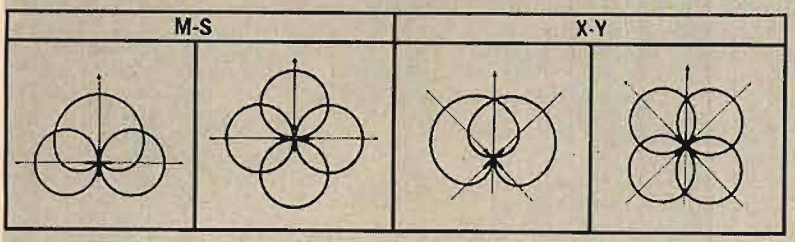

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education to parts distributors, to persuade them to enter the field of retail merchandising for high fidelity components.

B. Establishment of the Garrard RC-80 record changer in 1949, a product which literally made history in the field.

C. In 1950, he established the doctrine of the responsibility of the importer in the audio industry—a marketing policy based on the concept that no product should be imported unless it has some special characteristics to offer the American consumer not obtainable in domestic products . . . and supported by parts and service facilities at least as extensive as those behind the finest domestic products.

D. In 1955 and 1956, Leonard Carduner sponsored and presented the first concert-demonstration before an audience, comparing the sound of high fidelity components with that of the live performance. These were the concert-demonstrations by G. A. Briggs at Carnegie Hall. A full program was presented with the collaboration of Columbia Records and included comparisons of recordings with the artists alternating with the recording on the stage.

E. Introduction of the first Automatic Turntable, the Garrard Type A, late in 1960, a product which has now repeated the historic acceptance of the RC-80 changer, ten years later, by again establishing a new concept in record-playing equipment.

Mr. Carduner's attitude toward the Industry today is largely the same as it was 15 years ago. He is convinced that component music systems which can bring so much of genuine value, wholesome pleasure, and cultural benefit to a home, have hardly scratched the surface of their potential market. In his opinion, this market is to be sought in every corner of the nation. In accomplishing this, demonstration is highly important . . . consequently, BIC has been in virtually every high fidelity show since the first one. Due to Leonard Carduner's policy, BIC was probably the first exhibitor to arrange to participate in the first New York Audio Show, which established this pattern of marketing for the industry.

Under his direction, the company has also led constructively in its efforts to introduce components to the public, and today, with this in mind, he participates very actively with other leaders as a member of the Board of Directors of the IHFM. He encourages his personnel to engage actively in the activities of this association and other groups, as a fundamental part of their business careers at BIC.

He has played a notable part in breaking down barriers and creating the chain of distribution the audio field required in order to progress. His attitude toward success in this Industry ("while preserving one's sanity and having a little fun") is that its achievement hinges on two factors: 1. That the product (which has to be good) represent fair value, and be so represented; 2. That the seller be prepared to stand behind the product to complete satisfaction of the audio consumers who Mr. Carduner regards as an outstandingly sensitive and intelligent group of buyers.

Norman Crowhurst

Over 30 years ago, I didn't know how many grids there were in a pentode—and neither did the man who was interviewing me for a job, so he hired me! That's what started me in audio. Ever since, I've wondered if a qualification for being in audio is that you must know nothing about it. It often seems that way! Of well over 300 articles I've had published on this subject, not a few have been written to correct wrong notions that prevail, mainly because so many who work in the field don't understand what they are doing. I can say that here, because everyone who reads it will think it applies to someone else!

For example, several times I've written about cathode followers, to point up the fact—that anyone who measures what he does has already discovered—that when you load a cathode follower with a matching load, it does have low distortion at the same time. But people still write to me and tell me I'm wrong, quoting some college professor or text book as "authority." Why on earth can't they check what it was the professor told them and—assuming they have it right—check that it's true? And so it goes.

In that I have been "with" audio for these many years, I suppose I qualify as a "pioneer." But when asked what important milestones in high fidelity I have been associated with, it seems quite suddenly that I have done singularly little.

I developed a compact filter with variable-frequency m-derived cut-off—that was never exploited. I developed a universal crossover-cum-output transformer, capable of feeding any combinations of woofers and tweeters and matching any output tubes, with any crossover frequency—that was never exploited. I worked hard on the Perspecta-Sound system for putting on single track wide screen movies—that was never exploited. I developed a new type stereo loudspeaker that only needs one small piece of furniture in the room and isn't so critical of placement as the more conventional two-speaker systems—that was never exploited. And I've tried and tried and tried to get someone to adopt a sensible approach toward integrating the high fidelity sound system with the room acoustics, so that expensive, high-quality equipment isn't just wasted by improper use—and nobody's interested. Shall I go on?

It looks as if I've pioneered in ideas that weren't used. Before leaving this aspect, though—please—no letters to ask about how some of these ideas work, unless you're a manufacturer belatedly interested in the possibility of exploiting them!

One idea that nearly got exploited was the feedback loudspeaker system. I wrote a do-it-yourself article about six years ago, which resulted in a man contacting me who said he wanted to do it "properly." (Mr. Integrand—'nuff said.)

A hoax, that only my better judgment kept me from getting mixed up with, was a "perfect amplifier" to go with a certain "perfect baffle." I refused to have anything to do with it, only because I don't believe any amplifier (or baffle either, for that matter) can be perfect.

And for a while, I was having a running battle with a certain non-profit organization who told the high fidelity consumer that there is a one-and-only perfect loudspeaker, that can be made a little bit better if a certain electrostatic tweeter of Japanese make were added.

Of course, I've met numerous people in audio who've always done everything before the men usually credited with the various inventions in the business. I'd doff my hat to them, but that I don't wear one. What puzzles me, though, is why diamond styli (of .0005-in. radius), microgrooves, 45/45 stereo, reverberation lines, oxide tapes, bass-reflex cabinets, re-entrant horns, and all the other innovations of the last 30 years, weren't all in use long before 1920? Why did these people keep their inventions under their oversize hats, until someone else invented them? As a matter of fact, I have done some things before their "inventor" sounded a fanfare about them, but none of them strike me as important enough to mention (quoth he into his sleeve).

So much for what's got me no place ali these years. But we do eat, and I don't send by wife out to work, so how do I do it? In the early days, like Williamson, I designed amplifier circuits and audio systems in general. Nothing exactly unique, but we developed "sound" design methods. At Tannoy, where I worked for more years than I care to reveal, we had a happy combination of guys, including the Guy. Where other firms either adopted the sloppy "anything goes" attitude that never did a job properly, or the perfectionist attitude that never got a job finished, we had a compulsion to get work out the door ("or else!"), but we were our own best critics—it was never good enough and had to be better next time. That's a good combination for success.

After World War 2, when the rehabilitation to peacetime high fidelity was particularly bogged down by British Labor government red tape, I decided my fortunes would fare better elsewhere and moved out, along with some other "pieces of furniture."

Since then my writing activity has sought to place the benefit of my experience at the disposal of others. First my design methods were committed to print, then I expounded on the relative merits of different approaches to design and showed how to develop "short-cuts" to optimization. Sometimes I have thrown in a new circuit for extra measure (usually because the Editor said it wasn't worth publishing otherwise). A year or so following its publication, examination of schematics from manufacturers would reveal that several of them were using those suggested new features exactly as I had committed them to paper. Like Williamson, all the payment I got was for the original article. But unlike his circuit, they didn't even mention my name.

In any event, the Audio Engineering Society saw fit to confer a Fellowship

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on me "in recognition of the importance of his writings in the formation of a comprehensive audio technology.". . . As well as a few magazine articles, I've written a few books about it. In case you have difficulty counting up to 300 articles, some of them appeared under other names—like Ravenswood. Maybe it was ironic that, when a certain company was sued for using a certain respected name, they should pick the name Ravenswood to change to! But, although I used it before they did, I see no reason to sue. I couldn't afford to, anyway!

Arthur C. Davis

Some of Arthur Davis's developments in the audio field were: The vertical mixer control; pan pots in conjunction

with J. N. A. Hawkins of Disney Studios; brought out first passive program equalizers; developed and built the first magnetic sprocket driven sound-on-film recording machine (holds patent on this); has recently developed complete passive graphic equalizer; holds patent on polarized relay; on straight line attenuator, and coaxial TV type attenuator.

Sherman Fairchild

Sherman Fairchild first became commercially interested in audio when his company, Fairchild Camera & Instrument Corporation, in the early thirties accepted a contract to manufacture a disc recorder using aluminum discs. The owner and developer of this recorder was unable to move the inventory which the Fairchild Camera Company had built because the quality of the machine was so bad. In order to move this inventory, Fairchild put two of his engineers (now in the Bell Telephone engineering department) to work to redo the product. These engineers did such an outstanding job that the resulting recorder was accepted as the best of its kind, and this launched the Fairchild name in the audio business. Very soon aluminum records went out and acetate records came in.

Shortly after this time, Fairchild engineered and produced an extremely high-quality amplifier which was one of the first commercial amplifiers to use feedback circuits. These amplifiers were widely used in audio and were also used in laboratories as standard amplifiers.

Soon after that, audio development work was interrupted by the second World War. During their spare time, Fairchild engineers thought about audio products and about this time Ted Lindenberg came from Cleveland and joined the Fairchild organization. The thought was that Fairchild Camera would have a broad line of audio products after the war. Unfortunately for these audio developments, very large commercial subcontracts came into Fairchild Camera after the war and the introduction of their audio equipment was delayed until a large part of the post-war demand had been satisfied by other producers. Fairchild did have outstanding gear-driven playback turntables, recording lathes, cutters, pickups (moving coil) and arms (which some people will remember as the old "Cobra" arm).

At this time, it was also evident that tape was going to be coming into the market and Fairchild had no tape recorder and no engineers who were up to date on tape. To say the least, the outlook for the audio products part of Fairchild Camera looked rather dim and the directors and management of the company decided that it would be more profitable for the company to concentrate its efforts in other fields.

Sherman Fairchild, however, was tremendously interested in the audio business and did not want to drop it. At the same time, he had to think first of the interests of the stockholders in Fairchild Camera & Instrument. The way out of this dilemma which prevented the Fairchild audio equipment from being dumped on the market, was for Fairchild to form Fairchild Recording Equipment Corporation, put up the money for this organization himself and take over the inventory from the Camera Company and liquidate it in an orderly fashion for the Camera Company stockholders.

About this time, he made an arrangement to acquire the tape recorder engineered by Dr. D. G. C. Hare. One of the

prime movers in Fairchild Recording Equipment Corporation was Mr. Wentworth Fling, now Vice-President and Chief Engineer of Cinerama. Through Mr. Fling, and with the help of Dr. Hare, the Fairchild professional tape recorder was developed. This machine was full of innovations which gave not only better motion but better sound quality than other machines then available. Unfortunately because all of the audio components were plug-in and completely interchangeable, the piece of equipment was expensive and competitive equipment was offered at little over half the Fairchild price. Fairchild, however, did pioneer the synchronization of tape with sound in its pic-sync machine and even went to the point of developing equipment for CBS where the sync tape started up in sync with the motion picture film and maintained its sync for a period of an hour.

Fairchild designed and built equipment which printed frame lines and footage marks on tape so that it could be easily cut with motion picture film, but most motion picture film editors preferred to use the visible sound track with which they were well-acquainted. Although hundreds of tape recorders eventually were sold, Fairchild did not push its expensive machine. It is interesting today to note that these machines sell second-hand for as much as they originally cost new. Many people still consider them the finest professional equipment in the world at any price.

Fairchild Recording Equipment Corporation did push its line of hi fi equipment, both professional and for the audio fan. This company pioneered the first stereo pickup. It was the originator of the modern belt-drive turntable and today molds and manufactures its own belts. It brought out and installed in many studios, one of the two American stereo record cutters. Recently it pioneered the incorporation of cadmium sulphide cells in audio control circuits.

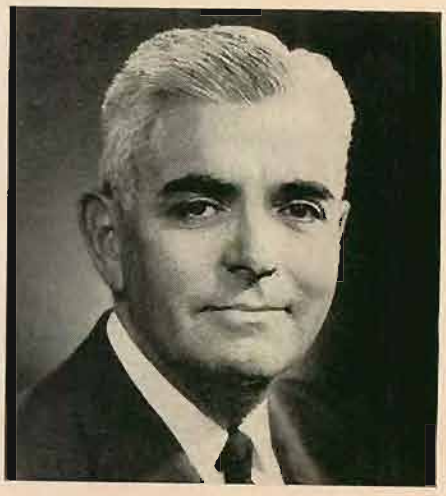
Fairchild's commercial audio history has not produced the largest volume of sales, but few companies have produced as many innovations or have pioneered as many new audio devices.

Avery Fisher

This year Avery Fisher is celebrating his twenty-fifth anniversary as a maker of high-fidelity equipment. As the dean of the industry, he looks back with pleasure on the tremendous growth of public interest in the audio hobby, mixed with not inconsiderable astonishment at its magnitude. For when he first opened the doors of his establishment in 1937, in a small loft on West 21st Street, New York, patrons were few and far between. The true practitioners of the hi-fi hobby were limited in number, as were the available sources of good programs—whether from records or radio.

Today Avery Fisher heads the largest high fidelity manufacturing facilities in the industry, with plants in New York, Pennsylvania, and New Jersey. The largest unit is also the newest; it is the 62,000 square foot Fisher plant on a twenty-acre site—Fisher Park, Milroy, Pennsylvania.

In spite of the magnitude of the company's operations, Avery Fisher has continued to maintain direct contact with hi-fi enthusiasts seeking information or



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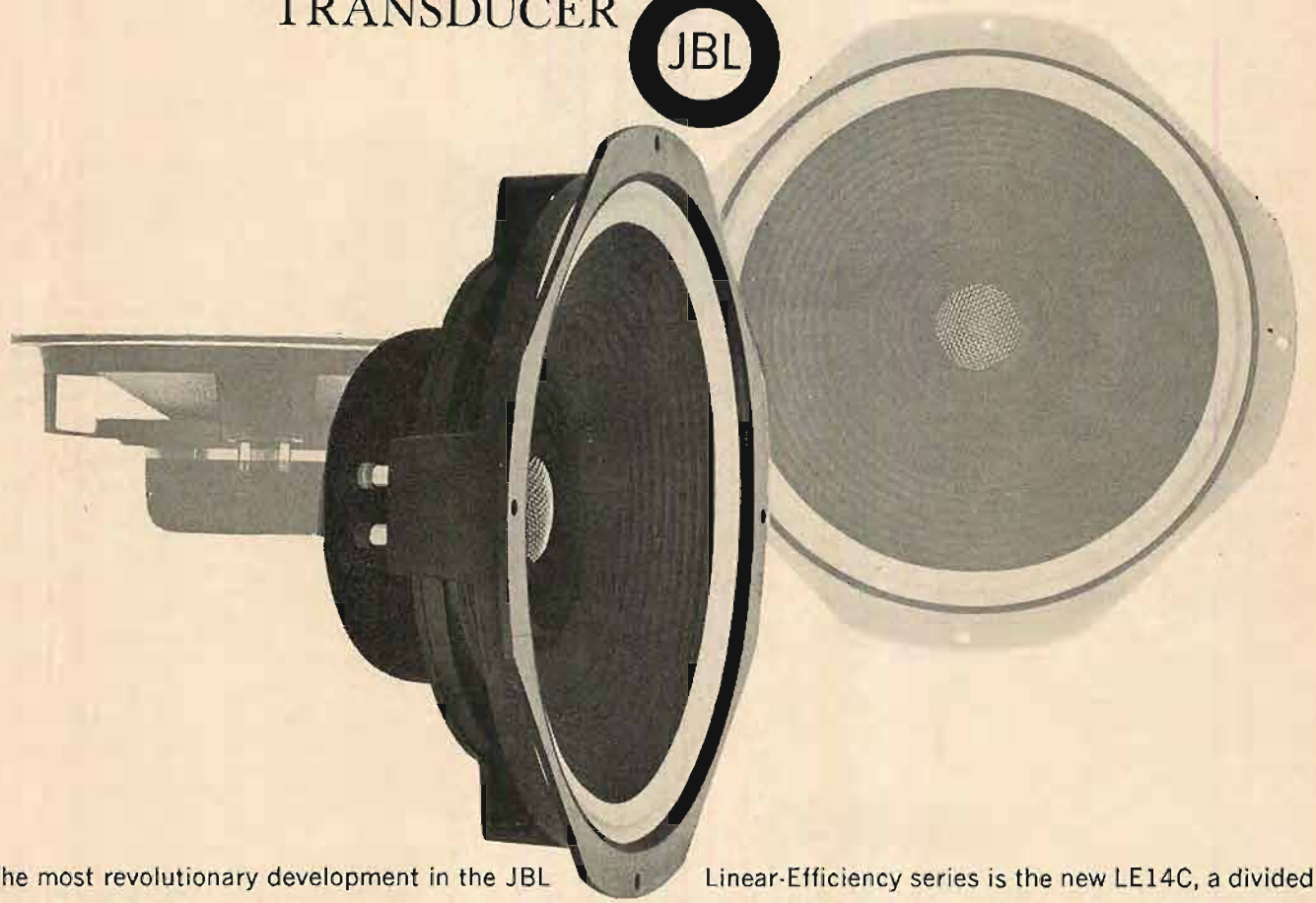

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Remarkably versatile, highly efficient, the JBL LE20 spans the sonic spectrum from 1200 cps to beyond the limits of aural perception. With its companion network JBL Model LX2, the LE20 can be used with either low frequency drivers or full-range speakers of either high, medium, or low efficiency. Preview listeners have been consistently impressed with the LE20's pleasant, clean, sensationally linear response. JBL Bulletin SB1204 describes the LE20 and LX2 in detail.

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NEW JBL OPUS, MODEL C52

Descended from the magnificent JBL Olympus and the versatile JBL Apollo, the new Opus is a compact, beautifully designed and finished Linear-Efficiency system for shelf or table-top. It may be ordered with either the S9 or S10 two-way divided network system installed. The former includes the LE75 high frequency unit, the latter the LE85. Both utilize the LE10B ten-inch L-E bass transducer. The exposed acoustical lens distributes sound smoothly through a 120° horizontal x 45° vertical pattern. Lens may be rotated 90° if vertical placement of the enclosure is desired. The Opus also accepts the new LE14C; in which case the lens is replaced by a wood panel. It measures just 28" x 14" x 14¼" deep.

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How did it all start? Most logically. Avery Fisher was born into a highly musical family, one in which each youngster was taught to play a musical instrument and was constantly exposed to music from Father's record collection. Charles Fisher, père, began his hobby at the time discs were replacing cylinders and turntable power came from a crank handle and spring with a maximum capacity of five minutes playing time.

Avery Fisher's mastery of the violin led, in later years, to the greatest of all participation experiences available to a musician—string quartet and chamber music sessions in his home. Begun thirty years ago, his collection of chamber music, reference library on musical subjects, and collection of recordings is perhaps without an equal.

He has had the privilege of building high fidelity equipment for the world's great concert artists, opera stars, for royalty and heads of state as well as world leaders in the fields of science, education, industry, publishing, broadcasting, and the theatre from the royal palaces of Bangkok and Teheran to the most modest of urban apartments.

Avery Fisher's first model (1937) featured a broad-tuning TRF tuner with a 20-kc bandwidth, and a twenty-five watt inverse-feedback amplifier, built on two chassis. In a ceremony at the Smithsonian Institution, Washington, D. C., early in 1960, this historic unit was accepted for the permanent collection of the Institution as the first commercially produced high fidelity instrument.

With the exception of the war years, when his company was engaged in the production of electronic equipment for the military, each year has seen new and basic developments from the Fisher laboratories.

Avery Fisher's long-standing reputation in industrial and typographic design is reflected in the appearance features of all Fisher products, whose styling he personally supervises. His reputation in the field of typographic design is such that when arrangements were completed for the American edition of Sir Winston Churchill's **"History of the English Speaking Peoples,"** the American publishers asked him to design these books, an honor he was delighted to accept. He is frequently asked, by those who encounter his name in these volumes, whether he has a relative or namesake who designs books.

Avery Fisher has been elected a member of The Players, as a patron of the arts. The club was founded in 1888 by Edwin Booth for leaders in the theatre, publishing, and the arts.

Guy R. Fountain

The initials "G.R.F." symbolize in Great Britain the initials not only of a well-known wide range of loudspeakers, but the initials of Guy R. Fountain—one of the earliest founders in England of high-quality, high-power audio apparatus in all its facets.

Due to the absence of high-voltage dry batteries in the early twenties, he patented and manufactured an ingenious range of battery eliminators, chargers, and an electrolytic rectifier which employed as the positive rectifying electrode an alloy of tantalum. He abbreviated "Tantalum Alloy" to TANNOY, and thus was born a registered Trade Mark, which during the war years appeared some eighteen million times on the European battlefronts.

The use of the Tannoy high-voltage rectifiers enabled high-quality power amplifiers to be pioneered using power triodes, which were the only valves available in those early days.

Mr. Fountain's organization grew steadily, and in the late twenties and early thirties, he was producing not only high-quality audio amplifiers, but amplifiers having undistorted outputs of 100 watts and more. In 1934, having equipped with superb-quality radio the British L.M.S. President's railway coach, he was commissioned to equip the Royal train, an installation which became the prototype for many high fidelity outfits. Even in those days, twin loudspeakers were employed. In 1934/1937, Tannoy high fidelity equipment was available, which represented the high standard available in that era.

In the Radio Exhibition of 1935, a high-quality stretched-diaphragm capacitor microphone was exhibited with a three-stage head amplifier contained in the tubular stand itself. This Exhibition also displayed loudspeaker characteristic recording equipment which Tannoy pioneered and manufactured not only for their own use, but for other manufacturers' laboratories.

At the beginning of the Second World War, Tannoy resources, which by this time had grown very considerably, were employed to produce a range of audio communication equipments for tanks, gun batteries, airfields, submarines, and so on, to such an extent that, by the end of the war, Tannoy had become almost a generic term for loudspeaker equipments, and even today in Great Britain people use the word Tannoy as a verb, indicating the act of broadcasting to large assemblies.

Peace saw further ramifications in the now broad field of Tannoy audio activities. Much effort and development lead to the design of the internationally known "Dual Concentric" loudspeaker; designed primarily as an audio measuring device between an electronic amplifier and the ear, it soon became a desirable commodity with the introduction of long-playing records, FM radio, and high-grade high fidelity in homes throughout the World.

Mr. Fountain's organization, however, was reaching out still further afield, specializing in speech reinforcement and simultaneous interpretation facilities. Tannoy equipment became permanent features not only in the House of Commons and House of Lords, Westminster, but Parliaments and Government buildings throughout the World, such as the House of Commons, Ottawa; United Nations, Manhattan; Geneva; Paris; and so forth.

The tradition and standards of Tannoy are still being promoted by Mr. Fountain and his elder son, Michael, who with his family still remain the sole proprietors of the Tannoy Group, which in turn is operated by executives, few of whom have been with the company for less than 25 years.

Sidney Frey

Forty-year-old Audio Fidelity President Sidney Frey started in the record business in 1948. Not by choice, however. A business venture that didn't pan out left him holding the bag—a "bagful" of esoteric Israeli folk records. Thousands of them. But the dynamic Mr. Frey managed to find retail outlets for these records . . . and almost as quickly as you can say "stereophonic sound" he was a record distributor. He obtained distribution rights to other unusual records (no one else wanted to handle them!) and was soon noted as a source for this kind of material.

At the start, the distributing company, Dauntless International, was a two-person operation—the other party was Frey's wife, Rogie. Today, the Freys live very comfortably in Riverdale and have two daughters, 6 and 8. Today, too, the Frey business family named Audio Fidelity, Inc., has expanded to nearly a hundred people and is a record-producing establishment—in both senses of the word.

A native New Yorker, Frey studied engineering at CCNY. World War II interrupted his studies and he shipped out as a ship's carpenter in the Merchant Marine; and following the war, he became an exporter—of machinery, or anything that "looked good." The last-mentioned occupation was what Frey was engaged in at the time he was precipitated into the record business. His only previous music "experience" was as an avid record collector, with a penchant for south-of-the-border rhythm (as indeed evidenced by one portion of the Audio Fidelity line).

Soon after becoming a distributor, Frey—being Frey—began to dabble in producing his own records. You would call most of the records he recorded and/or distributed off-beat, collectors' items or source material. Such as "What You Can Learn From The Kinsey Report," "Hitler's Inferno," "War of the Worlds," and "The Search For Bridey Murphy." The first smash hit, however, was "The Investigator," which was based on the famous McCarthy trials.

At any rate, these records (besides bringing a first measure of fame to Frey in the record producing business) made enough money to enable him to launch Audio Fidelity, in 1953.

Frey's Audio Fidelity Stereodisc was the first commercial stereophonic record to be produced and marketed. It constituted a major development in phonograph records and the most significant change since the transition from cylinder to disk. And it is an acknowledged fact that by putting his Stereodisc on the market when he did, Frey forced the

entire industry into an all-out stereo program. Audio Fidelity released its first Stereodisc (made by the 45/45 Westrex cutter) to the industry in November, 1957, to offer to the manufacturers a pure vinyl record that would last for months. This first Stereodisc (Audio Fidelity's own name for its stereo product) was offered free of charge to accredited members of the component and recording industry via a single advertisement in a trade publication. Needless to say, Audio Fidelity was deluged with requests.

The next move of the industry, now that it had such a record with which it could perfect cartridges, pickups, amplifiers, and so on, was to get it out on the market. And it was Frey who made it to market first. The first Stereodisc was offered to the buying public in February, 1958, at the West Coast Hi Fi show and also via a demonstration at Macy's in New York. And the Age of Stereo was launched.

Frey characteristically admits that his neck was stuck out. The Westrex cutter was so new that even at this point he doesn't hesitate to admit that all the bugs have not been totally removed. But he says, like the turtle, progress can only be made when you stick out your neck.

Not only is Frey fanatical about maintaining the very best standards possible in producing his records, but he feels most strongly that information given to the public should be completely correct, clear, and to the point. People should be guided to distinguish true stereo sound from faked or gimmicked stereo sound, so that the term "stereo" does not become an abused one and bandied about like "hi-fi."

Robert Furst

Furst seemed to have been destined to his final avocation from his early life on. He was born into a family where engineering had become a tradition. He grew up surrounded by the intellectual atmosphere of the post-World War I Vienna of Weingartner, Furtwaengler, and Bruno Walter. He still recalls the many rain drenched afternoons he spent under an umbrella standing in queue for a "Stehplatz" in the rear of the upper balcony of the Vienna State Opera. After attending the University for an engineering degree, he found himself, during the political upheaval of the late thirties transferred to Chicago, Ill., where he completed his formal education at the Illinois Institute of Technology.

In 1942, Furst joined the engineering staff of Majestic Radio and TV Corporation where he found himself quickly involved in a new "art," FM radio, first for military and later for home entertainment applications. Under the tutelage of Majestic's chief engineer, Dudley Foster (Foster-Seeley discriminator), one of the great pioneers of the early radio era, he gained first hand knowledge of the intricacies of FM. Significantly, Furst has been involved in FM tuner and music home entertainment systems ever since. In 1950, Furst joined the David Bogen Company as Assistant Chief Engineer where he made the acquaintanceship of Sidney Harman and Bernard Kardon. In 1952 he joined Harman-Kardon as Vice President, Engineering.

In the ten years of collaboration between Kardon and Furst, many intelligible designs have evolved, and hi-fi components have been brought out of the attic into the living room. The haywire "bucket-of-bolts" approach, acceptable to the small coterie of prewar specialists, has been replaced by sleek styling and simply organized controls that delight the homemaker. The Citation series based on a cost-no-object approach provides performance unequaled previously outside the laboratory. It is interesting to note, however, that the advances in tuners and amplifiers over the past twenty-five years have not been by virtue of startling breakthroughs, but by continual painstaking refinement. Frequency response of 20 to 20,000 cps now has been widened to 2 to 100,000 cps. Distortion has been pushed down to immeasurably low levels and phase shift, which previously was never even considered important, is now carefully controlled.

What of the future? Furst is up to his ears in a transistorization program and expects to spend the next few decades doing the thing he loves best, improving the quality of music in the home.

Peter C. Goldmark

Dr. Peter C. Goldmark was born in Budapest in 1906, and studied at the Universities of Berlin and Vienna, receiving his Ph.D. in physics from the latter.

In 1936 he joined Columbia Broadcasting System, Inc., as Chief Television Engineer, later becoming Director of the Research and Development Division.

The first practical color television system was developed under the direction of Dr. Goldmark in the CBS Laboratories, and on August 27, 1940, the first color broadcast in history was made from the CBS Television transmitter in New York.

During the war CBS Laboratories, under Dr. Goldmark, was responsible for many military developments in the field of electronic countermeasures and reconnaissance. After the war the long-playing record was developed by Dr. Goldmark and his associates in the CBS Laboratories.

In 1954 Dr. Goldmark became President of CBS Laboratories and Vice President of CBS, Inc.

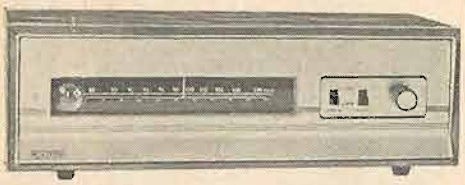
Dr. Goldmark is a Fellow of the Institute of Radio Engineers, the American Institute of Electrical Engineers, the Society of Motion Picture and Television Engineers, the Audio Engineering Society, and the British Television Society. In 1945 Dr. Goldmark was awarded the Television Broadcasters Association medal for his color television pioneering work. Dr. Goldmark is the only member of the Institute of Radio Engineers to hold both the Morris Liebmann Memorial Prize for electronic research, which he received in 1946, and the Vladimir K. Zworykin Television Prize, awarded to him in 1961. In 1960 Dr. Goldmark was given the Achievement Award by the Institute of Radio Engineers' Professional Group on Audio. He is also a visiting Professor for Medical Electronics at the University of Pennsylvania Medical School.

David Hafler

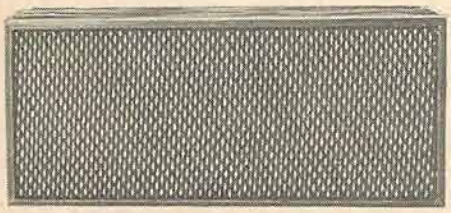
Born 1919. Was interested in music first, then in musical reproduction in mid-thirties. Got involved in the separate woofer-tweeter, bass-reflex, audiophile approach about 1938. Majored in mathematics at University of Pennsylvania—AB 1940. U. S. Coast Guard 1942 to 1945 during which I had my first exposure to sophisticated electronics when I got an assignment as communications officer and was given responsibility for radar, loran, sonar, and radio equipment.

On return to civilian life found that the old hi-fi rig had expired and it was necessary to build a new one. This led to a long period of trial and error which led to partnership with Herb Keroes in the formation of Acro Products. We started this transformer business in order to get a high-quality output transformer in order to make a good amplifier. At that time, the two of us wanted to produce amplifiers, but the transformer business turned out to be suffi-

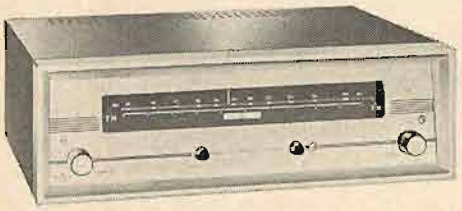
MX-100. STEREO MULTIPLEX ADAPTER KIT. All critical circuitry factory adjusted and prealigned. Maximum stereo separation between 20-15,000 cps, with low distortion. Stereo switch permits either front-panel separation control or maximum separation adjusted at factory. Kit: $49.95; Factory Wired, ready to operate: $69.95.



ST-26. FM TUNER/AMPLIFIER KIT. Low-cost combination hi-fi FM music system. Requires only the addition of external speaker (see L-3) to complete system. Pre-Built Front End fully adjusted and prealigned at factory. Kit: $54.95; Factory Wired, ready to operate: $69.95.



L-3. SPEAKER SEMI-KIT. Ultra-compact, graciously styled system. Lifelike response from high-efficiency speakers. Walnut-finished cabinet. Size: 13¼" L x 6½" H x 7¼" D. Semi-Kit: $19.95.

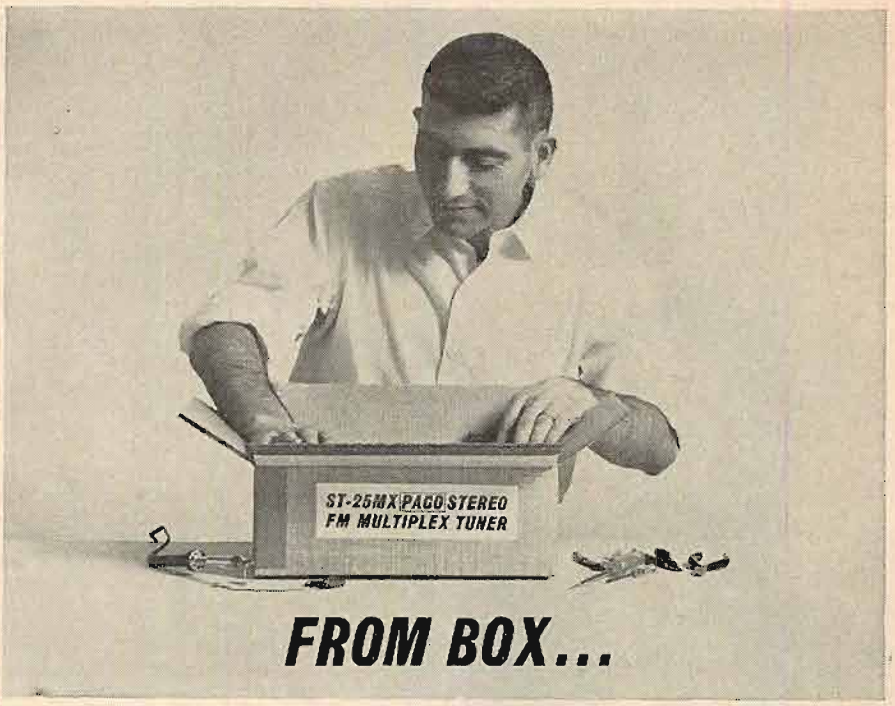


ST-35 MX. FM STEREO MULTIPLEX TUNER KIT. Designed for maximum sensitivity, selectivity and stability. Full, prealigned multiplex circuitry incorporated. Kit: $99.95; Semi-Kit: $119.95; Factory Wired, ready to operate: $139.95.

SA-40. STEREO PREAMP-AMPLIFIER KIT. 40 watts RMS (20 per channel). Stabilized feedback circuit insures optimum performance with all types of speaker loads. Harmonic distortion: less than 0.5% at 20 watts. 14 panel controls. Kit: $79.95; Factory Wired, ready to operate: $129.95.

PACO KITS

THE KITS YOU BUILD IN 1/3 LESS TIME



FROM BOX...

TO BEETHOVEN IN 1/3 LESS TIME!

In timed, competitive tests, twin brothers — with twin backgrounds and skills — proved that Paco kits are faster, easier and more fun to build than almost-identical kits sold by other kit makers. They discovered that there's no guessing with Paco: parts are neatly packaged and precisely labeled; instruction books are complete and easy to follow. Accurate drawings to actual scale and fold-out diagrams are printed right next to step-by-step directions. ■ The twins also proved that Paco pleasure doesn't end with the wiring. The ST-25 MX FM Stereo Multiplex Tuner*, for example, looks and performs like twice the price: frequency response is 30 to 20,000 cps within 2 db; sensitivity is 1.5 μv for 20 db quieting. It features self-contained, prealigned and fully shielded front end, FM Stereo multiplex circuitry, dual limiters, AFC with panel switch for AFC defeat and "eye"-type tuning indicator. Why not put Paco to your test. Kit: **$69.95** net, (factory wired, ready to operate: $99.95). See your dealer or write today for details to Paco Electronics Co., Inc., 70-31 84th Street, Glendale 27, New York, a division of Precision Apparatus Company, Inc. Export: Morhan Corporation, 458 Broadway, New York 13, New York. In Canada: Atlas Radio Corporation, 50 Wingold Avenue, Toronto, Canada.

*AS PICTURED ABOVE

PACO KITS

THE KITS YOU BUILD IN 1/3 LESS TIME

ciently attractive to justify postponement of production of amplifier business.

Up to this point, I had been engaged in marketing research—an outgrowth of my mathematical background. Now, however, I switched to the electronics field.

After six years in the transformer business, with heavy emphasis on audio transformers, I went into business for myself with the foundation of Dyna

Company. I decided to specialize in high fidelity kits because I had just spent six years dealing with amplifier builders and felt that I had not only absorbed their problems and viewpoint, but that I could offer them kits which would free them from the problems of hacking at chassis and debugging their own circuits. This has been my major activity since 1955 when the first Dynakit was produced.

I think that my contribution to high fidelity (some people may think that it is a negative contribution) is that I helped to popularize high power. This in turn made the low-efficiency speaker practical. This came about in two steps. The ultra-linear circuit, of which I am co-inventor, immediately doubled the power output of the popular triode circuits like the Williamson circuit. Then, the first Dynakit, the Mark II, was a 50-watt unit which brought this power range to a mass market. I think that my work has led to providing more watts per dollar throughout the high fidelity industry, and the result of exposing people to higher power has been to demonstrate that power required for good reproduction was greater than most people had realized.

H. A. Hartley

I was born in 1900 and I am a Scot. My first name is not Harold, although **Esquire** seemed to think so when it wrote me up a few years ago; the first Harold got an arrow in the eye in 1066, but I have so far escaped mortal inury. True I have fenced with Gilbert Briggs from time to time, as **Audio** readers will have noted, but we keep the buttons on the foils, for we wouldn't like to hurt each other, and he did me the honour of writing me up in his **Audio Biographies**, so I won't repeat the grisly story here.

It was as a result of work with the late P. K. Turner that the world's first so-called high fidelity speaker was created. In 1926 we thought we had done much better than our illustrious contemporaries Rice and Kellogg and I thoughtlessly called the sound of it "high fidelity", little knowing what that would lead to. That, in fact, was my most infamous invention.

So fas as actual technicalities are concerned, Turner and I jointly developed the first freely-suspended self-centering speaker. We not only devised the original spider washer but the only one that imposed no restraint on the voice coil, and that old device has never been improved on by anyone. Along with this went our free outer suspension which not only damped the free edge of the cone but imposed no restraint on its movement. Speakers incorporating this free suspension were put on the market by Hartley Turner Radio Ltd. in 1930 and I have heard that some of those speakers are still working perfectly well in Britain today.

Our other original device was the Bakelite cone. In those days there was no hope whatever of moulding them and we made them out of flat sheet cut to shape and cemented. But to avoid creating a flat spot anywhere in the cone, our joint was a spiral, making a complete revolution from apex to outer edge. So, although the outer edge was free it remained circular, essential if resonances were to be avoided.

In 1937 I made a step forward. After some heartbreaking experiments I managed to produce about a dozen speakers fitted with moulded Bakelite cones in which the compound was almost pure resin. I demonstrated these at the Glasgow Radio Exhibition in 1937 and everybody thought they were the most wonderful speakers that had ever been devised, and I still think so. Unfortunately the cone-producing technique was so chancy that I couldn't go into real production, and we had to carry on with the made-up cones until the second World Was put a stop to all our work, and during that war Turner died.

Meanwhile, as we had produced a non-resonant speaker it seemed to me desirable to produce a non-resonant enclosure, so I dreamed up the thing which came to be called the Boffle, and it was and is a truly non-resonant baffle. Since it became well known in the U. S. I have been often told that it doesn't do the speaker real credit, but it does. What it doesn't do is add false bass, and all the other enclosures and fancy cabinet devices I have studied seem to me to fail because they are resonant.

I suppose I am an old-fogey purist, but it does seem to me that as a speaker in its enclosure has to make an attempt to reproduce every kind of musical noise, it must have no "personality" of its own. It must be absolutely unbiased; it must add nothing and take nothing away. The unit itself calls for vast experience of what does distort (since we can only approximate to perfection), and apart from mass of the moving parts (which impairs transients and 'attack'), what must be avoided at all costs is resonances. I just don't believe that a resonance in the speaker can be neutralized by a counter-resonance in the enclosure with any precision, so if one has a non-resonant unit it demands a non-resonant enclosure. I wrote a constructional article on how to build a Boffle for **Radio-Electronics**, and I had a pile of letters from readers who said they had built Boffles for speakers with a bass resonance and found the combination wonderful. In other words get rid of all the resonances you can.

Of course it reduces the apparent bass, but that brings up one of the toughest problems that can harass a high-grade speaker manufacturer. High fidelity does not imply powerful distorted bass that can shake the foundations nor synthetic top which goes through your head like a sword. It is an attempt at realism, and is not an impressive commodity at a High Fidelity Fair. I know, from experience of them in New York and London. Everybody means well, but it just isn't a "commercial proposition" to make any

attempt to demonstrate real quality when others are bending the walls with distortion at +90 decibels.

When I was able to resume production of speakers in 1946 I couldn't obtain my old prewar Bakelite sheet (I originally got it from Germany), and at that time I couldn't get the special cement. Everybody else used felted paper, but the snag with that was that it didn't reproduce the high notes. I had the brainwave of introducing a midcone compliance with the idea of isolating the apex from the comparatively huge mass of the cone. I didn't know at the time, but later an inventor showed me a British specification in which he had had the same idea, but it fell down through the wrong technical approach. Mine did work, and the well-known Hartley 215 speaker was born. It was so successful that I was tempted to have a go at the potentially vast American market.

I had no idea how to start, but I examined all the American magazines and came to the conclusion that a rather slender one called **Audio Engineering** might fill the bill, my idea being that if I could interest the audio boys they would tell the great general public. So January 1949 was for me a great moment, for my first foreign advertisement appeared in what is now **Audio**, and I met C. G. McProud and his quite delightful staff. I wrote my ads in a simple straightforward way. I said what I sincerely believed to be true about the speaker, and the funny thing is that quite a lot of people believed it too and sent me their orders. I shipped them direct from London, real personal service.

The thing grew to such an extent that I took a chance on showing them at the 1951 Audio Fair. Hartley's comic column had appeared on the back page of **Æ** for two and a half years and it was pulling in the orders. I had earned enough to pay my way across, buy a room at the New Yorker Hotel, and do my stuff. It was a tough time. I arrived when one of the usual waterfront strikes was operating in New York and was warned that any attempt to clear my

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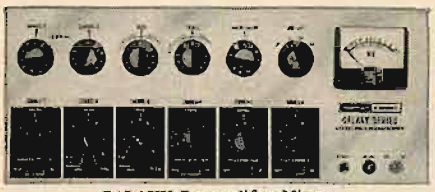

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Just a few features found on the GALAXY Series: Remote control of level, AC power and standby operation; Monitor jack as well as optional monitor speaker or VU *meter; Constant voltage outputs, both balanced and unbalanced; Bridging connections; Low Cut Filter, Speech Filters;* NARTB *Mic Inputs; All plug-in accessories; Response and distortion specs that satisfy the most stringent requirements.*

GALAXY Power Booster

Built *by* Sound Men *for* Sound-Men

harman kardon

HK-71

goods would mean broken heads. But I pay my tribute to the Customs officers. We unpacked the stuff in the customs sheds, had it checked, put it in suitcases which were laid on the floors of taxis and got away in safety. Those Customs men were real guys! And that was the beginning of the Hartley era in the United States. It was never a big market but it was a loyal one, and brought me many friends. My enormous mail gave me a greater insight into what makes America tick than could have been derived in any other way, and it all started from that first ad in Æ!

I sold my London business in 1953. I was never a routine worker. I wanted to create, design, innovate, and I was getting bowed down by the daily chores. It was arranged that I should start a sales office in New York and the new owners would continue to supply speakers to me there. But it didn't work. The personal touch had gone, and so had the quality; so much so that the new owners ceased production entirely in 1957. As I had too many commitments in England to start production in the U. S. it has to be recorded that the last genuine Hartley speaker was sold in 1953.

Well, so be it! Since that time I have been brooding on the shape of high fidelity to come. In between writing books and other ways of keeping the wolf from the door I keep on working in my English laboratory. I wrecked my wife's hi-fi phonograph four years ago because I thought it sounded lousy, and she keeps on nagging me as to when she'll get another. Maybe she will sometime this year, for I think I am beginning to see daylight. For some time I have instinctively felt that hi-fi as we know it is played out. The kick we enthusiasists got out of it 15 years ago isn't there; it has become the inevitable accompaniment of the café society, beatnik, and ordinary ways of living. I'm not trying to be sncoty; everbody is entitled to a hi-fi outfit, but to my ears it isn't a musically real outfit. I don't blame the manufacturers; the bigger they get the more remote becomes the "touch of the master." The stuff isn't there, although it may be wonderful value for money in a material sense.

Of course, in the last count, we are all at the mercy of the producers of tape and discs. They do pretty well, but I would like them to do better, and, as happened with stereo, I wish they would get their experimental work done before they put the stuff on the market; it makes it cruel hard for us poor designers.

Dr. John K. Hilliard

Dr. Hilliard received his B.S. degree from Hamline University in 1924, following which he did graduate work in electrical engineering at the University of Minnesota. He received a D.Sc. in Engineering from Hollywood University.

Dr. Hilliard's experience includes fourteen years with MGM Studios working on the development of recording and reproducing film and tape equipment, and the design of microphones and loudspeakers for theaters. He was Project Engineer at the Radiation Laboratory, Massachusetts Institute of Technology, on radar. He has spent seventeen years with Altec Lansing Corporation as Vice President, Advanced Engineering Department. Dr. Hilliard's work has included the development of transducers, communication equipment, and high-intensity sound environmental equipment

to simulate jet and missile engine noise to evaluate fatigue of electronic equipment and air frame structures; microphones to pick up heart sound; communication equipment for telephone systems; and anti-submarine warfare equipment.

Dr. Hilliard is a Fellow of IRE, Acoustical Society of America, Audio Engineering Society, and Society of Motion Picture and Television Engineers. He is a member of Eta Kappa Nu Engineering Fraternity, Armed Forces Committee on Hearing Bioacoustics, Institute of Environmental Engineers, and AIEE. He is also an Acoustic Consultant, for the Brain Institute, U.C.L.A. Medical School. He received the John H. Potts Memorial Award for outstanding achievement in the field of audio engineering in 1961.

He has published 60 papers in IRE, SMPTE, Electronics, Acoustical Society, and Journal of Environmental Engineers.

Arthur A. Janszen

I was born in corn and cotton country in Texas, on a rolling prairie near Yoakum, nearly fifty-five years ago. In 1912 I decided to leave home for good and make my own way, but I changed my mind about a mile down the road. When my parents picked me up, hot, tired, and hungry, I thought it might be a good idea to wait until I was at least six. Actually, I didn't leave again for fifteen years. In that time we moved from a relatively gentle community into a frontier area near the King Ranch's

feudal domain, a hundred miles from the Mexico border.

My post-high school education began when I enlisted in the U. S. Navy for four years, "to see the world." My travel expectations, seemingly justified by the recruitment poster of that time, were thwarted by President Hoover, who apparently thought it more important to save oil than to send our fighting ships around the world for the purpose of subjecting foreign coastal populations to the amenities of our ships' men. Since it was clear that the battleship I was on, the U. S. S. **Wyoming**, wasn't going to travel, I transferred after a year to the Balboa, Panama Canal Zone radio station.

After Balboa, I spent an enchanting year on a three-man radio station in the rain forest on the southern shore of the Isthmus of Panama, near the Colombia border, at a village named La Palma. The following year was spent in the utility (euphemism for entertainment) squadron at the Naval Air Station, Coco Solo, Canal Zone. Our function of supplying transportation for visiting important persons to and from points of non-military interest around the Canal Zone triggered a development program that gave birth to a "first" in aircraft communication. One of the points of interest, a mountain vacation retreat, was too distant for two-way radio communication between Zone stations and planes equipped with standard equipment. I helped my friend, Chief Radioman Harvey J. Woods, build and flight test the first short-wave aircraft transmitter and receiver for the Navy.

While still at home, I had built and sold a number of battery-operated radio receivers prior to 1926. Some were pretty good. With a good antenna, I was able to listen over a loudspeaker to the 500-watt station of KDKA in Pittsburgh at five o'clock in the afternoon during the winter time, using a set with four UV-199 tubes. Although I flunked the Navy examination for entrance to their radio school, which was an inevitable result of my walking out of the test session, my transfer to the radio division aboard the Wyoming was executed without difficulty with the aid of Chief Radioman Larry Stansell, of Galveston, Texas, who invited me to bring my horse. My first exposure to what might be called high fidelity came about when the captain decided that the crew of the Wyoming needed some music. Since the top deck was the only place in which the crew could congregate in reasonable numbers, the music had to be loud. Therefore, if one uses one of the criteria that is too often still used in evaluating high fidelity equipment, this playback system must have been at least partially high in fidelity.

From 1943 to 1945, I worked at the Harvard Underwater Sound Laboratory as a Special Research Associate, on the development and field *testing of underwater ordinance*. During this time I was elected to membership in Sigma Xi. In 1945, the ordnance section of the Underwater Sound Laboratory was transferred to Pennsylvania State College. It functioned in its new location as the Ordnance Research Laboratory, and was populated largely by ex-Underwater Sound personnel, including me. I remained as Associate Professor of Engineering Research in charge of the laboratory's field test station in Ft. Lauderdale, Florida, until I returned to Harvard in 1946 as a Senior Research

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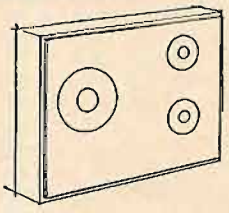
Here is unbelievably excellent sound quality combined with the ultimate in placement flexibility. Compact size (12⅞"H, 15⅜"W, 2⅝"D) takes little space on desk, table or shelf. The slim-compact X-20 is ideal for wall mounting with built-in brackets. Finish is oiled walnut. Convenient volume control on the side. There's a refreshing decorator touch in the two-tone harmonizing custom fabric on the front. 3 speakers—a woofer and 2 tweeters—provide smooth wide range sound. Perfect for FM Multiplex, very low cost stereo, other-room extensions.



X-20 3-speaker 2-way system. Impedance, 8 ohms. Power rating, 6 watts. Adequate room sound with 1 watt to speaker.
In Oiled Walnut....**$39.95**

...ultra-compact X-10

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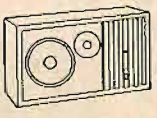

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Division of THE MUTER CO.
LOUDSPEAKERS

Jensen Manufacturing Co., 6601 S. Laramie Ave., Chicago 38, Ill. / Canada: Radio Speakers of Canada, Ltd., Toronto / Mexico: Universal De Mexico, S.A., Mexico, D.F.

Assistant in the Acoustics Research Laboratory.

At the Acoustics Research Laboratory, in connection with the projected measurement of the transient response of a microphone array, the investigation of the transient response of loudspeakers as sound sources was undertaken. The results of a series of tests indicated that meaningful data on the transient response of a receiving array could not be obtained without a prior development of a suitable sound source. Electrostatic transduction was chosen for the source. New materials had become available since electrostatic loudspeakers dropped out of sight in about 1932. By 1953, the first push-pull, full-range electrostatic loudspeaker capable of producing high acoustic pressure levels had been developed, and an experimental model was shown during a meeting of the American Physical Society in Cambridge, Mass., in January of that year.

In 1954, the Magnetic Amplifier Corp., of Waltham, Mass. became Janszen Laboratory, Inc., of Cambridge, Mass., with me as president and general manager. With the indispensable aid of my wife, the development of the first commercially-practical electrostatic loudspeaker (mid and high frequencies) was completed, and production began in April, 1955 under the name JansZen Model 130. This loudspeaker is now made by the Neshaminy Electronic Corporation.

In early 1959, the first production models of the full-range electrostatic loudspeaker, now being manufactured and sold by the KLH Research and Development Corporation as its Model Nine, were delivered. Prototypes had been placed in the field during 1957 and 1958.

During 1959, the assets of Janszen Laboratory were transferred to the KLH Research and Development Corporation, of Cambridge, Mass., and I became a stockholder and a vice president of KLH. My activities include the development of new industrial and home-entertainment products, production engineering, and general administration.

My family and I live in Belmont, Mass., just beyond the Cambridge boundary. My wife, Pearl, and I have three lovely children named David, Karen, and Eric, whose ages are 6, 5, and 4 years respectively.

I am a member of the Acoustical Society of America and of the American Association for the Advancement of Science.

Albert Kahn

If **Audio** is 15 years old this month, it must have been earlier that year that I was approached to support a magazine devoted exclusively to audio.

Not much circulation to tap—yet the field was growing. Could advertising revenues be sufficient to warrant a monthly publication? With so much folderol being written—how could this new magazine establish integrity and authenticity?

I had an axe to grind. Electro-Voice was coming up fast in the microphone business and potential users were hard to pinpoint. I wanted one strong publication to spearhead our advertising program. I remember giving a commitment for 14 full pages the first year if the magazine came into being.

The rest is history. I do feel, however, that **Audio** has done more than give us a medium that we needed. It has been a decided influence in raising the standards of audio quality—and benefitted everyone—the publishers, too, I hope.

Bernard Kardon

Music—its storage and recreation—is the basis for the hi fi industry. This fundamental fact is sometimes submerged under a flood of claims, but Bernard Kardon has never lost sight of it. Reproduction of the emotional content of music, as well as its structure and form, has been his guiding force during his many years in the industry.

Bernard Kardon was born in 1914 in New York City, the third of five children. His parents had an unusual combination of music interest and engineering talent. His mother, whose main interest other than her family was the piano, exposed each of her children to a fundamental education in music. His father, one of the original members of the legendary Bronx Radio Club, was a pioneer in radio manufacturing, producing stamped circuit tuners and amplifiers as early as 1920.

Kardon was first introduced to his life's work in 1922 on a visit to his father's plant. Formal education at technical schools (Stuyvesant High School and Cooper Union) was supplemented with practical experience, first as a radio repair man and later as an engineer. An early marriage (the Kardon's will celebrate their 29th anniversary this year) was a settling influence.

In 1937 he entered the employ of the David Bogen Company as a design engineer, later becoming chief engineer, a post he held through World War II. In 1950 he left the post of Executive Vice President of that company to start the predecessor of Harman-Kardon, Inc.

During the 1930's, his work centered around sound systems in the then-new talking movies and for schools. There was no general public interest in hi fi, but a small number of recording engineers and musicians were assembling systems in their own homes, selecting the better components wherever available and modifying them to suit. Kardon found that a large part of his time was spent modifying and calibrating special versions of PA equipment for these specialists. Before long it became obvious that specially designed equipment was needed to satisfy this small market. This was a labor of love, and required research into basic questions cutting across physical, psychological and physiological boundaries.

The war years interrupted this work. His time was devoted to producing equipment for the Armed Services. As a specialist in sound reproduction he was assigned problems in designing intercoms with maximum intelligibility under acoustic and psychological conditions of combat, beachmaster systems to enable direct voice communications from the shore to landing crafts a mile out, and sound simulation equipment to decoy the enemy into wasting his reserves in attacks on non-existent concentrations of strength. Other areas included sonar and voice communication between ships and convoy under radio silence.

The post war years brought an explosive growth in home entertainment via electronics. FM broadcasting, LP records, tape recording, stereo records and lately, multiplex FM stereo has caught the public interest. Now he occupies his time in planning and initiating new projects and guiding the over-all engineering investigations on a broad basis—away from the daily responsibilities of management.

Paul W. Klipsch

Paul Wilbur Klipsch was born on March 9, 1904 in Elkhart, Indiana. He received a B.S. degree in electrical engineering from New Mexico State University, University Park, N. M., in 1926, and the degree of Engineer from Stanford University, Stanford, Cal., in 1934.

He was employed in the testing department of the General Electric Co., from 1926 to 1928; the Anglo-Chilean Nitrate Corp., Tocopilla, Chile, from 1928 to 1931; the Independent Exploration Co., Houston, Texas, from 1934 to 1936, the Subterrex Co., Houston, from 1937 to 1941; and the U. S. Army Ordnance Dept. At present he is the owner of Klipsch and Associates, Inc., Hope, Arkansas, manufacturer of loudspeakers.

He is a Fellow of the Audio Engineering Society, a Senior Member of IRE, a member of AIEE, the Acoustical Society of America, Tau Beta, Pi, and Sigma Xi. He is a licensed professional engineer in Texas and Arkansas. He is also a member of Scimitar Temple (Shrine), the Sojourners.

"My first loudspeaker was a cardboard

just for the record

the NEW RONDINE 2 has added an extra motor

REK-O-KUT, maker of the world's finest turntables, combines the superior quality of single play turntable with Auto-Poise — the first motor-actuated tonearm. To achieve this unique record playback system, REK-O-KUT designed this unit with two motors, each of which performs separate functions. One motor drives the turntable quietly at a constant, accurate speed. The second motor actuates an electro-mechanical device which, at the press of a button, places the tonearm on the record at one gram force, removes it automatically at the conclusion of the recording, returns it to the arm rest, and shuts off the turntable. From the first groove to the last groove of your record, Auto-Poise is disengaged and the tone-arm is completely free-floating and independent. If you want turntable perfection, distinctive styling, un-equaled engineering and workmanship in a single compact factory-assembled unit that will fit any cabinet, then the RONDINE 2 is for you. Ask your dealer for a demonstration or write for free descriptive literature.

Model R-320A 33⅓ rpm Turntable with Auto-Poise motor actuated tonearm **$169.95**
Model R-320 with S-320 Tonearm **$129.95**
Model R Turntable only **$79.95**
Model R Base **$14.95**

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"horn" attached to a Brandes Superior earphone in 1920. It was a far cry from that to the dihedral corner horn of 1940 and from there to the Klipschorn of the present day.

"Adherence to basic physics has resulted in designs of a durable nature. There have been no 'breakthroughs' experienced along the way. The result has been the production of spakers which have negligible obsolescence."

Harold J. Leak

Mr. Harold J. Leak, M.Brit.I.R.E., was born in 1907. He has spent his life interested in and contributing to technical advances which have resulted in the highest quality of sound reproduction. In contrast to his modern laboratory in which he works, he lives, with his wife, two sons and daughter, in a beautiful 15th century house in the countryside a few miles out of London. He is a keen angler and a bird-watcher, being particularly interested in bird photography.

His interest in radio started while he was still at school where he obtained permission to found the School Wireless Society.

He entered the electronic industry at the birth of sound motion pictures in 1929 as an electronic engineer. In 1934 he founded his own company with the aim of earning a living in a way which appeared to hold the best promise of a happy life: by making sound reproducing equipment better, if possible, than anyone else. His company, H. J. Leak & Co. Ltd., has grown to be the largest firm in England exclusively devoted to high-fidelity audio engineering.

During the last war his first factory was bombed and the factory to which he moved was later destroyed by incendiary bombs: his home was destroyed by bombs and his next house was damaged by bomb blast. However he did not allow these incidents to interrupt seriously his war work, which was the design and manufacture of high-reliability low-distortion audio amplifiers for the Forces and research laboratories engaged on war work.

In 1945, as the result of war-time research in his laboratory he was able to offer audio amplifiers with a distortion content as low as 0.1 per cent. A survey of technical publications from 1945 onwards will confirm that his firm was the first in the world to design and market amplifiers with such a small distortion content, and the magnitude of this advance can be gauged when it is remembered that the then accepted standard for laboratory amplifiers was 2 per cent distortion. The figure of 0.1 per cent was received with incredulity, but it was subsequently confirmed by the National Physical Laboratory and this criterion is still an accepted world-wide standard.

With this clear lead on low-distortion amplifiers his company was able to build up an export market much greater than the domestic one, and the increased volume of manufacture resulted in lower prices which, in turn, brought real high-fidelity amplifiers within the reach of the music-lover at home. Mr. Leak further popularized high fidelity by lecturing throughout the country and giving demonstrations of comparisons between live and recorded voices and music.

When the first Audio Fair in the U. S. was being arranged in 1949 the organizers sent Mr. Leak an invitation to participate with a plan of the demonstration rooms and an application form: he made up his mind to exhibit but at that time Britain was short of dollars, sterling had just been de-valued, and Treasury permission to spend dollars had to be obtained: thereby hangs an amusing story. Treasury permission was given and Mr. Leak cabled the organizers "Will participate please reserve room 49 dollars available." After some lapse of time, and not having received a reply, Mr. Leak telephoned the organizers: yes, they had received his cable but they couldn't let him participate for $49 and they considered the matter closed. Mr. Leak explained that the 49 referred to the number of the room he wanted and that ample dollars were available. Now that all was clear, Mr. Leak was made welcome and his was the only British firm to exhibit at the first U. S. Audio Fair.

Mr. Leak became a member of the Audio Engineering Society of America and was subsequently honoured by being made a Fellow.

C. J. LeBel

Born Dec. 16, 1905 in New York City, C. J. LeBel attended the Mass. Inst. of Tech., and received a B.S. in 1926 and an M.S. in E.E. in 1927. From 1927–29 he was a research physicist with Raytheon, Inc. working on lamps and rectifiers. In 1929–1932 he was a research engineer with Sylvania Electric Products and worked on lamps, ozone tubes. From 1932–1937 he worked as a consultant on sound recording problems. From 1937–1942 he was Chief Engineer, and from 1940-now, Vice President, of Audio Devices, Inc. where he worked on lacquer recording blank discs and magnetic recording tape. From 1942–45 he was Chief Engineer of The Maico Company working on hearing aids, hearing test equipment, electronic stethoscope and a surgeon's metal locator. In 1945–46 he was a Project Engineer at Cambridge Instrument Co., working on hearing aids and electronic stethoscopes. In the years 1946–47 he worked as electronic consultant, Damage Control Project, at Stevens Institute in a study of ships' motion. Finally, from 1947-now he has been Chief Engineer of Audio Instrument Co., Inc.

He is listed in "American Men of Science," "Who's Who in the East," "Who Knows—and What."

Mr. Lebel is a Fellow of the Audio Engineering Society; a Member of the Acoustical Society of America; an Active member of Society of Motion Pictures & Television Engineers; and a Fellow of the Radio Club of America.

Books he has authored are "Fundamentals of Magnetic Recording" and "How to Make Good Tape Recordings" both published by Audio Devices, Inc. and both best sellers.

Impingement of Lebel on Audio Field:

At Raytheon his first patent has since turned out to be one of fundamental patents on the fluorescent lamp (the much litigated "LeBel Patent"). All audio products are built under fluorescent lamps.

At Audio Devices LeBel was active in the first automatic machine production of lacquer recording discs in America, and in American application of these discs. Audio Devices rose from "nothing" to the largest American maker of lacquer discs in one year and still is the largest. He supervised development of the first Audiotape magnetic recording tape. He also helped write many sound recording standards.

At the Maico Company LeBel applied psychoacoustics to hearing aid design. It was here, at Maico, that he helped write the first standard on methods of measuring performance of hearing aids and developed the Maico Stethetron, the first really successful electronic stethoscope.

At the Audio Instrument Co., Inc. LeBel developed an intermodulation meter with extremely low internal leakage, capable of reading very low values

Another exciting hi-fi development from PIONEER: the PT-P1 pleated tweeter. A look at the characteristics of this new tweeter will show you that the differences between it and ordinary paper cone and unpleated diaphragm tweeters are truly important ones.

1. Absolute stability in characteristics and tone quality — ideal for stereo.
2. Superb frequency and directional characteristics.
3. Frequency characteristics and tone quality equivalent to those of horn tweeters.
4. Because of low crossover frequency, it offers a dynamic mid-range even in a 2-way system.

Also, see PIONEER's high-performance "C Series" woofer — the perfect mate for the PT-P1.

UNIQUE TWEETER DIAPHRAGM!

High-performance tweeter PLEETER PT-P1

SPECIFICATIONS

V.C. Impedance	8 or 16 ohms
Frequency range	2,000 — 16,000 cps
Power input	20 watts
Sensitivity	104 db/watt
Total flux	21,000 maxwell
Flux density	13,500 gauss
Crossover frequency	over 3,000 cps

PIONEER "C Series" woofers with powerful magnetic circuit

10" PW-25C 12" PW-30C 15" PW-38C

Specifications

	PW-25C	PW-30C	PW-33C
Resonance frequency	40 — 55 cps	35 — 50 cps	30 — 45 cps
Frequency range	35 — 4,000 cps	30 — 4,000 cps	30 — 3,000 cps
Power input	15 watts	20 watts	30 watts
Sensitivity	103 db/watt	105 db/watt	107.5 db/watt

PW-25C

PW-30C

PW-38C

PIONEER

PIONEER ELECTRONIC CORPORATION

5 Otowacho, 6-chome, Bunkyo-ku, Tokyo, Japan

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Canada:	Importhouse of Canada.	2939 Eglinton Avenue East, Scarboro, Ontario
Malaya:	Hwee Seng & Company.	259 Beach Road, Singapore 7

of IM. This has been improved year by year; present leakage is 0.015 per cent (just fine for measuring 0.1 per cent distortion). Subsequently he developed logarithmic amplifiers (loggers) which are used to convert linear recorders to a db scale. These utilize a highly developed and patented instant acting varistor converter. A magnetic tape time delay recorder was his next development, using sliding heads to adjust delay time. Used to solve echo problems in auditoriums or theaters with balconies, by use in conjunction with public address systems.

Frank H. McIntosh

We entered into the audio amplifier business and the associated hi fi field through the need for a better product we required in connection with a music-for-industry operation in Cincinnati, Ohio. After the war, we discovered great difficulty or impossibility of making purchased amplifiers perform according to their own specifications.

As a side line to Consulting Radio Engineering, we investigated the feasibility of developing an amplifier which would perform across the entire audio spectrum first without an output transformer, then, as the facts of life became more evident with an output transformer which would be efficient and do the proposed job. First we made a standard push-pull amplifier which put out 50 watts and which required six-807 tubes. It was operated almost Class A and it weighed nearly 125 lb. but delivered the required power. This didn't seem very practical as almost no one could lift it, let alone afford it.

The next procedure was to utilize the more efficient Class-B circuit technique not generally used in audio systems which meant higher efficiency and therefore less weight and less cost. The value of low leakage reactance between primary windings needed for Class-B operation was tested using a single frequency and tuning out the leakage reactance. This proved a sound idea for a single frequency. Then in order to accommodate the whole audio spectrum instead of one frequency the unity coupling bi-filar winding of primaries suggested itself. This was tested and found to work very well. The problem of how to drive such a system was most taxing and required many trials and efforts. Finally the unbelieveably simple circuit was developed using a 1-to-1 driver transformer. This made the whole idea possible and the inherent advantages of this circuit was available for commercial use.

There were several advantages to this circuit which we at first did not fully appreciate. As designed initially it was capable of unbelieveable bandwidth operation and provided 50 watts from a pair of 6L6's at less than 1 per cent distortion at any frequency from 20 to 20,000 cps—performance far beyond anything yet made for commercial use. Even today this is better than many audio amplifiers available. This was a 1949 design and the result of three years of development and a dollar investment of six figures. Gordon Gow, Vice President and General Manager of McIntosh was a major factor in the early development and Sidney Corderman, Director of Engineering has made the modifications since the first development of this circuit.

It was first thought that this amplifier would not be a factor in the audio field as it was felt its superior performance would not be noticeable in actually listening but we were wrong and its performance became one of the turning points of improved quality and standards. We hope it has helped to advance the art toward the perfection of sound reproduction.

Robert Newcomb

Newcomb Audio Products Co. was organized 25 years ago by Robert Newcomb. His purpose was, and still is, to offer the sound-equipment user the best quality of sound products. He was among the first, if not actually the first, to use inverse feedback in commercial amplifiers. Newcomb amplifiers have earned a national reputation for reliability. Newcomb was early in offering compact design styling to the hi fi trade, as well as being early with true remote control, and the first to offer plug-in input transformers.

The line now includes both ½-track and ¼-track stereo recorders of high performance with cybernetic design for ease of operation of the transport. The company is still owned and directed by its founder Robert Newcomb and continues to be dedicated to quality.

Dr. Harry F. Olson

Dr. Olson received the B.S., M.S., Ph.D., and E.E. degree from the University of Iowa, and an Honorary D.Sc. degree from Iowa Wesleyan College. He has been affiliated with the Research Department of Radio Corporation of America, the Engineering Department of RCA Photophone, the Research Division of RCA Manufacturing Company, and RCA Laboratories. He is Director of the Acoustical and Electromechanical Research Laboratory of the RCA Laboratories.

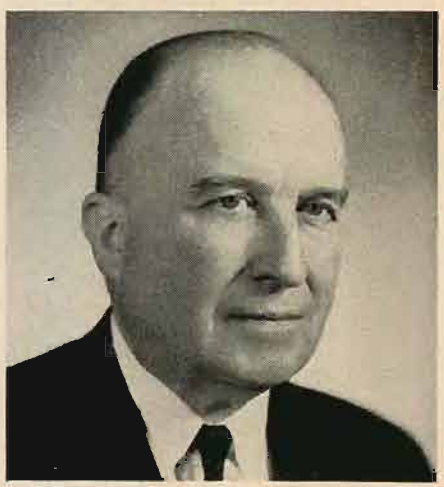
Dr. Olson is a past president of the Audio Engineering Society, past president of the Acoustical Society of America, and past chairman of the Administrative Committee of the IRE Professional Group on Audio.

He holds more than 90 U. S. patents. He is the author of 85 papers and the books "Elements of Acoustical Engineering," "Acoustical Engineering," "Dynamical Analogies," and "Musical Engineering."

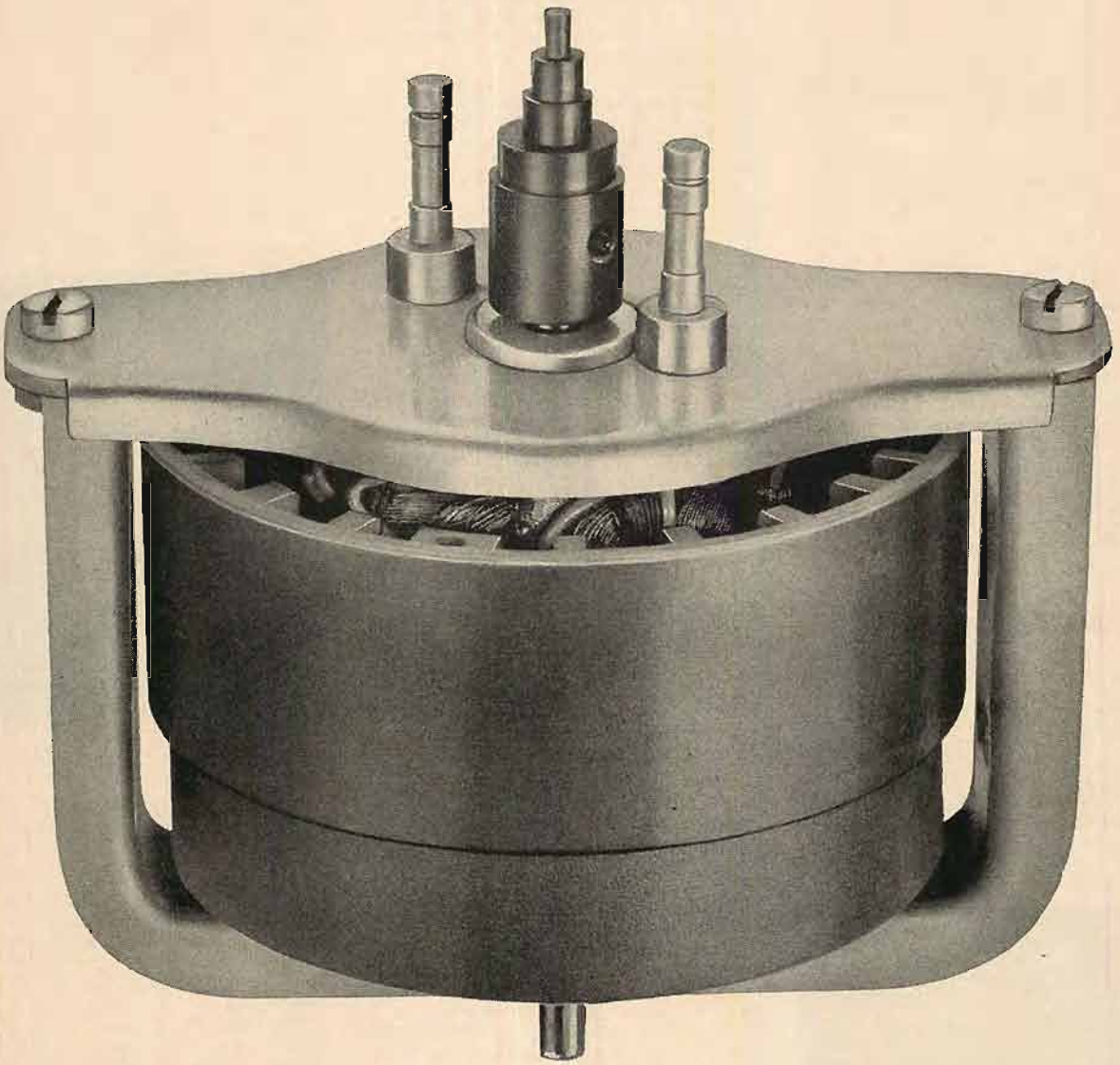
Dr. Olson has received the following honors: The Modern Pioneer Award of the National Association of Manufacturers, the John H. Potts Medal of the Audio Engineering Society, the Samuel L. Warner Medal of the Society of Motion Picture and Television Engineers, the John Scott Medal of the City of Philadelphia, and the Achievement Award of the Professional Group on Audio of the Institute of Radio Engineers.

Dr. Olson's pioneering work in the development of gradient bidirectional and unidirectional microphones with uniform directivity patterns started in the late twenties. These microphones demonstrated immediately outstanding efficiency in discrimination against noise, reverberation, and other unwanted sounds. As a result, gradient directional microphones have been universal since that time in all applications of high fidelity sound pickup.

In the late twenties Dr. Olson pioneered in the development of high-efficiency, large-throat, cone-driven, horn loudspeakers. Since that time this type of horn loudspeaker has been used for reproducing the entire audio frequency range and in conjunction with small-throat horn loudspeakers for reproducing the low-frequency range.



He was responsible for demonstrating that direct-radiator loudspeakers employing a double voice coil and other expedients could reproduce the entire audio frequency. He also demonstrated that uniform directivity with respect to frequency could be obtained from direct-radiator loudspeakers by employing cones graduated in inverse size with respect to the frequency. In the late thirties he developed a low-resonant-frequency loudspeaker employing a folded edge or accordion suspension.



an accurate timepiece

A clock or watch is undoubtedly more convenient for telling time. Yet, it is actually possible to keep accurate track of time with a hysteresis motor-driven Miracord turntable.

The speed of a hysteresis-synchronous motor is precisely regulated and timed by the frequency of the line current. This speed is constant even with variations in line voltage and load.

Consequently, a hysteresis motor-driven turntable will rotate at the precise record speed, and maintain that speed regardless of voltage fluctuation, or the number of records on the platter.

The Miracord 10H uses the famous Papst hysteresis motor with the outside rotor. It's the same motor employed by the finest professional turntables and tape transports. The external rotor is a dynamically balanced mass. As it spins, it acts as a flywheel, further smoothing and evening out the motion of the turntable.

You can see this flywheel effect with the turntable platter removed. After starting the motor by lifting the arm from its rest, you let it run for about 10 seconds. You then shut the power off, by replacing the arm. The rotor will continue to spin by the sheer momentum of its own mass for at least 20 to 30 seconds. Most motors will stop in about 3 seconds.

MIRACORD

The Miracord is the only record playing instrument with hysteresis motor, dynamically balanced turntable and mass-balanced transcription arm which you can play manually, or as automatically as you please. The Miracord is also available with 4-pole induction motor — the Model 10, priced at $79.95. The Miracord 10H with hysteresis motor is $99.50. Prices include arm, but are less cartridge and base.

Make it a point to see the Miracord at your high fidelity dealer soon. For details, write to:

BENJAMIN ELECTRONIC SOUND. INC. 97-03 43RD AVENUE. CORONA 68. NEW YORK. SOLE U.S. DISTRIBUTOR FOR ELECTROACUSTIC® RECORD PLAYING COMPONENTS

The mechanism operated in a small closed cabinet in which the compliance of the air in the cabinet provided the controlling acoustical impedance in the low-frequency range. This was the first commercialized system employing this principle for obtaining low distortion which has since become widespread in use in high fidelity small-enclosure loudspeakers.

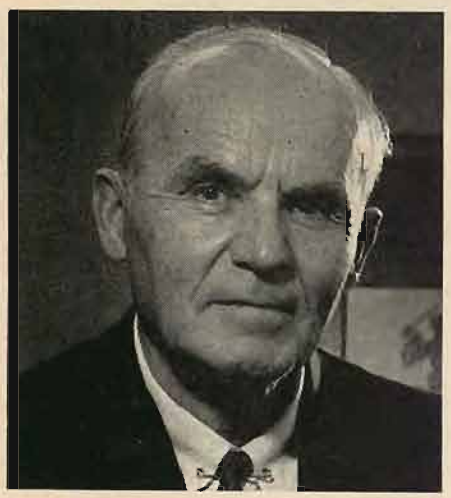
During World War II he was engaged in the development of sonar and other systems for antisubmarine warfare.

Dr. Olson developed the first active type sound absorber employing an electronic system for cancelling out or absorbing unwanted sound or noise. Several experimental applications have been made of this system, as for example, the reduction of noise by an air conditioner.

With Mr. Belar, they developed the RCA Electronic Music Synthesizer which can produce from a coded paper record any audible sound whatsoever regardless of whether it has been produced before or not. The RCA Electronic Music Synthesizer Model II is now used by Columbia and Princeton Universities for the production of electronic music.

A. M. Poniatoff

Mr. Poniatoff started Ampex with six employees working in the loft of a furniture shop and today the company has 4500 on its payroll. I think you will agree that this is a remarkable 18 years' achievement. This has been done without sacrificing technical standards (it is of course a fallacy to assume that big business always means mass production and price cutting). It is interesting to note that A. M. Poniatoff named Ampex with his own initials plus "ex" from excellence.



In addition to the tape recorders for which they are so well known, the company makes recorders for scientific instrumentation and computers, for missile centres, flight tests and space travel, automation, heart beats, brain waves and muscle vibrations. (So far as I know, there is no official recording of Mr. Poniatoff's original brain wave in 1946, when he mastered the mysteries of the German Magnetophone.) I will not enlarge on the subjects of flight tests and space travel as these are very much above my head.

Last but not least is the fabulous Videotape recorder, which records vision and sound on magnetic tape at the very reasonable speed of 15 ips, ready for TV transmission immediately after rewind. Its introduction in April 1956 touched off a revolution in television. Within a few days, Ampex received orders for 100 machines at $45,000 each.

Here is what Mr. Poniatoff has to say about the beginning:

"Magnetic recording as it was developed in Germany by Telefunken during the World War II (under the name of Magnetophone) was brought to the attention of several companies in the United States as a possible new product. The general reaction was that the equipment was not practical and would not have any future due to the fact that it was very cumbersome to thread the tape through the head, tension arms, idlers, and so on. Furthermore, the tape could be broken at any time and this would be very serious trouble, especially where the recorder was used for professional recording or played on the air by radio stations.

"My reaction was entirely different. After experimenting with the Magnetophone I had so much confidence in the future of magnetic recording that I gambled the whole future of Ampex by devoting full time and all resources of the company which was very limited in size (25 people) and limited in capital. This was in 1946 when I first had an opportunity to get acquainted with the Magnetophone and the above decision was made.

"When the first units were constructed, the radio stations were not willing to take a chance and put a program on the air recorded on a magnetic recorder for the reason I mentioned above.

"At that time, Bing Crosby had an opportunity to listen to our unit, and he recognized the outstanding quality of reproduction as compared with the discs which were used up to this time by all radio stations. Under his pressure, and on his programs, our first unit were used on the air.

"During our first demonstration of the Model 200 in New York, the top technical experts of the radio and recording industries were gathered to evaluate the quality of our equipment. Our representative who was in charge of the demonstration arranged an orchestra in a separate studio and sound was brought into another studio for the listeners with an A-B switch in their hands. On one position of the switch they were listening to the orchestra through the recording system. On the other position of the switch, they were listening to the same orchestra after it was recorded and instantaneously played back to them. The positions of the switch giving either direct sound or recorded sound were unkown to the audience. Our representative, knowing that in the past where discs were used the recorded music suffered from loss in the area of high frequencies, equalized the playback of our unit in a manner that the high frequencies were slightly in excess of normal. All the listeners unanimously stated that they knew which position would give them direct sound and which was recorded. Special remarks were made that a group of experts which was present had ample experience to know the difference between recorded and directly played music. Obviously, they were mistaken in selecting the position of the switch and everyone highly embarrassed.

"This was the beginning of the new era in magnetic recording of major radio networks in the United States."

(This section from **"Audio Biographies"** by G. A. Briggs.)

P. A. Rasmussen

Mr. P. A. Rasmussen, President of Viking, is probably typical of the immigrant who came to America looking for a job, and ended up as an employer and manufacturer with products known and sold around the world.

Mr. Rasmussen is inclined to play down his own part in what transpired, indicating that he is only typical of thousands of people who have come to this country. He came to America from Denmark just after the turn of the century. He was 18, and had one ambition: to work with machinery. In Denmark

this would have necessitated a four-year apprenticeship totally without income. In America he hoped to find someone who would pay him while he apprenticed as a mechanic. He did—at 5¢ an hour.

"However," he says, "don't think that was bad. In those days we worked a twelve-hour day, and that added up to $3.60 a week." In due time, the kid from Denmark became a machinist, a tool and die man, and eventually a shop foreman—bull of the woods.

In 1942, Mr. Rasmussen took his savings and set up shop for himself. Drawing on his good Nordic background, he named his new company Viking Tool and Die. The company grew and prospered, and in 1955, Viking Tool and Die entered the relatively new high fidelity field with a product, the familiar Viking 75 tape transport. Viking of Minneapolis was born.

Only a tape deck was involved at that time, but the high fidelity tape enthusiast is basically a recordist, and component recording amplifiers and playback amplifiers were quickly added to the line.

When tape equipment began to find application in the background music business, and later in the educational field for language teaching, Viking tooled equipment catering to these specific applications. The ability to move quickly, upon faith in its products and in the future of tape, has played a strong part in the growth of the company.

Today Viking of Minneapolis occupies two plants with a total area of 80,000 feet, and is still growing.

Mr. Rasmussen freely admits that he can't hear 15,000 cps even when produced with a Viking Stereo Compact, but he is the last Dane in Minneapolis who would deny that it has to be there —on the tape.

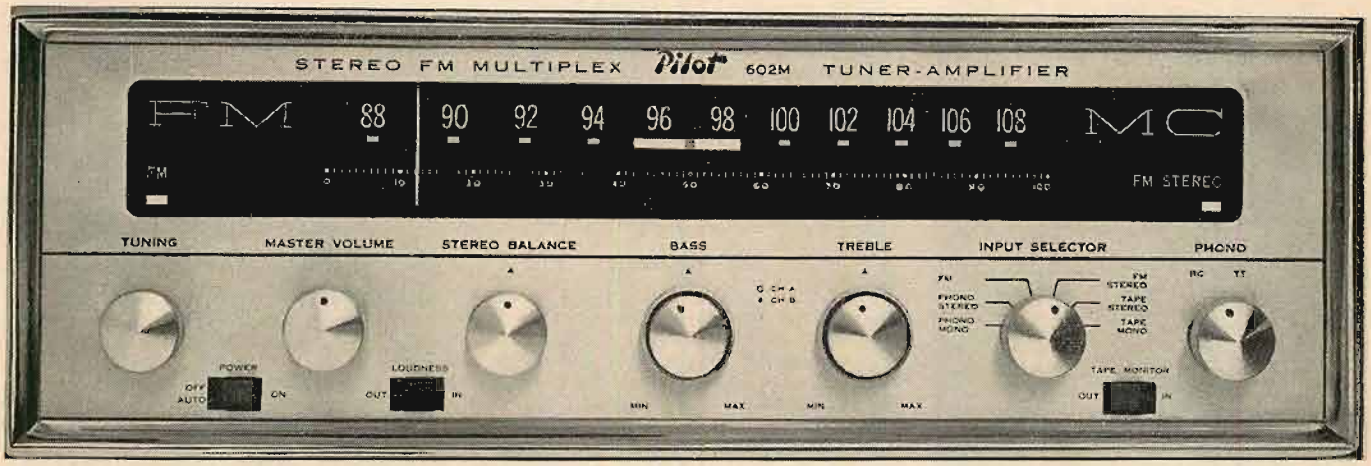
Hazard E. Reeves

Hazard E. Reeves, founder of Reeves

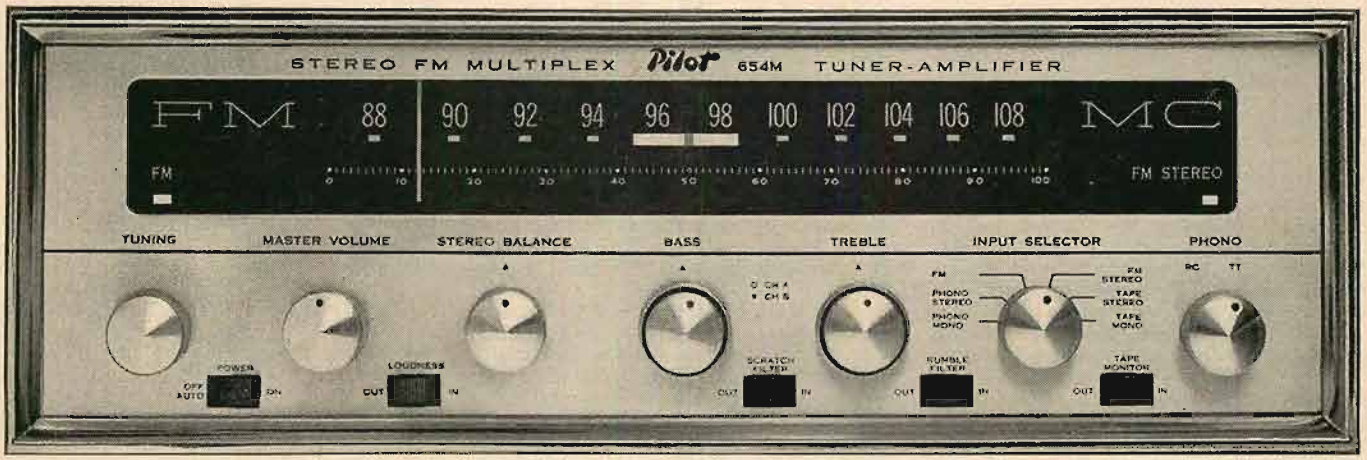
Only these FM Stereo Receivers have Pilot's unique signal-sampling multiplex circuit*

You get the best possible FM Stereo reception because PILOT's unique signal-sampling multiplex circuit gives you maximum separation (30 db or better) across the entire audio spectrum. It is the simplest, most effective, most trouble-free circuit presently being manufactured for stereo demodulation. There are no troublesome frequency separation filters and matrices or extra controls as are required by other multiplex circuits. This is just one of the many features that make PILOT Stereo Receivers the perfect electronic "heart" for your high-fidelity system.

*Patent Pending



PILOT 602M...30 watts music power...frequency response 20-20,000 cycles, ± 1 db...harmonic distortion 1% at full power...12-control flexibility...FM sensitivity 3 uv IHFM...wide band RF and IF circuits for undistorted reception at full modulation...6 inputs...5⅛" high x 14⅝" wide x 10¾" deep. With cover... **249.50**
(Also available with added AM as Model 602S. Complete, 299.50)



PILOT 654M...60 watts music power (IHFM mid-band rating)...frequency response 10-50,000 cycles plus 0.5 db or minus 1 db...hum and noise: completely inaudible (80 db below full output)...intermodulation distortion: less than 0.3%...14 controls, including rumble and scratch filters...6 inputs...**plus** a fully automatic stereo indicator that lights on stations broadcasting FM stereo...5⅛" high x 14⅝" wide x 12¾" deep. Black and brass styling. With cover... **329.50**

Pilot FOUNDED 1919

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ized high-fidelity tone arm known as the Auto-Poise.

Mr. Silber was one of the prime movers in the founding of the Institute of High Fidelity Manufacturers in 1956, and its first president. His term of office as president extended from 1956 through 1959. In 1960 he was Chairman of the Board of Directors of the Institute. He has been a member of PACE since 1936 and is now a member of its Board of Directors.

Walter O. Stanton

Walter O. Stanton was born in Canton, Ohio and studied Electrical Engineering at Wayne University. Following college he joined the Electronic Control Corporation, one of the first companies to apply electronics to the now widespread field of industrial automation. Continuing to specialize in that field he became Vice-President and Chief Field Engineer of the Detroit Universal Duplicator Company where he developed and patented an electronic servo system which enabled any standard machine

tool to produce complex contoured machined parts automatically. Immediately thereafter and for a period of five years he was associated with Control Instrument Company, Inc., now a Burroughs division, as Assistant Vice-President in charge of Engineering. Control Instrument Company specializes in fire control systems, servo applications and automatic control devices. He joined Pickering and Company, Inc., in 1948, and has served as Chairman and President since 1950.

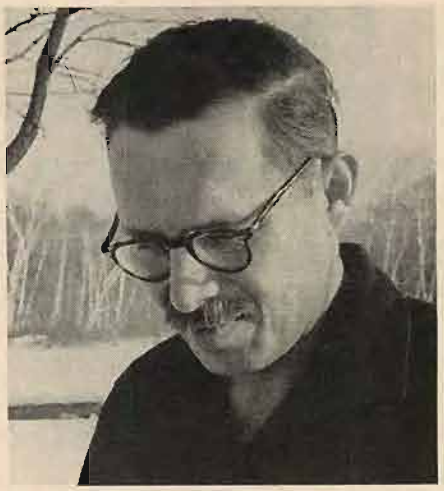
In addition to patents granted, Mr. Stanton has been responsible for component and systems developments in the fields of automation, fire control, and audio, including the invention of the Fluxvalve and Stereo Fluxvalve Pickups.

Mr. Stanton was President of AES in 1957 and served four years as a Governor. He is currently Vice President of the Institute of High Fidelity Manufacturers.

Edgar Villchur

Indicating his well organized (and modest) thought processes, Ed Villchur presented his biographical information as follows:

1. 1951–1956 instructor in electronics and audio reproduction, NYU Division of General Education.
2. 1952–1954 contributing editor of **Audio Engineering.**
3. Author "Handbook of Sound Reproduction" published by Radio Magazines in 1957.



4. 1956 awarded U. S. patent No. 2,775,-309 on acoustic suspension speaker system.
5. 1958 applied for patent still pending on hemispherical direct radiators used in AR-3.
6. 1962 completed design of AR turntable-arm. Patent application made for damping release mechanism of arm.
7. Currently President and Director of Research, Acoustic Research, Inc.

Paul Weathers

Paul Weathers is well-known and respected in the audio industry for his many contributions to the art and especially for his remarkable FM phonograph pickup. However, few people know the extraordinary background of this quiet and unassuming man.

Mr. Weathers received his education in electrical engineering at Indiana and Purdue Universities. In 1929 he was employed by the Radio Corporation of America, and thus began an association which lasted until 1945. Mr. Weathers' first duties with RCA were in the field of sound motion pictures. Then followed the years of research and development in the allied fields of public address and sound reinforcement and industrial electronics.

Mr. Weathers was responsible for many developments during this period. Among his more noteworthy accomplishments were an automatic beverage inspection machine for Coca-Cola and other bottled beverages, a machine for the detection of contamination and other imperfections in milk bottles, the development of new techniques in large screen television for use in theatres and improvements in theatre sound equipment.

He developed new sound equipment for the New York and San Francisco World's Fairs, developed the first multiple antenna distribution system for radio and television now in operation in Rockefeller Center in New York, and made many contributions to phonograph reproducing equipment. Mr. Weathers left RCA as Product Manager of the Sound Department, but was retained to conduct development work in industrial and tape recording.

In April, 1950, Mr. Weathers formed his own company, Weathers Electronic Industries, in Collingswood, New Jersey. The company's original business consisted of an egineering product design and development service for the electronic industry and the production of audio amplifiers for electronic organs sold by the Allen organ company.

In June, 1950, Mr. Weathers gave a technical paper on a new type of phonograph pickup. Instead of the usual piezo-electric or magnetic type of cartridge, his pickup was a frequency modulation unit—in essence a miniature FM transmitter, employing an oscillator and demodulator in the circuit. Because the stylus in the cartridge merely traced the lateral modulations in the recordings, rather than performing any mechanical work which resulted in electrical impulses, the cartridge and the associated specially designed arm was capable of tracking at the stylus force of one gram.

Several design changes, were made and at the conclusion of successful tests it was decided that the unit was ready for commercial exploitation. In 1953, the company was incorporated and capitalized to finance the new production and sales activity.

In 1955, Weathers Industries entered the loudspeaker field with an ultra compact design. This was followed with designs for very-high-power loudspeakers having very high efficiency.

In 1955, Weathers Industries entered the turntable field with a new approach

to the problem of maintaining a high degree of speed accuracy, free of annoying flutter, wow, and rumble. This turntable was driven by a very small hysteresis-synchronous motor only slightly larger and more powerful than an electric clock motor. The entire motor board assembly was floated on springs tuned to a very low sub-sonic frequency to eliminate acoustic feedback and jarring of the tone arm and pickup due to heavy footsteps on highly compiant flooring. This new turntable principle has stood the test of time and usage.

Paul Weathers is known in the high fidelity field as a practical perfectionist who doesn't develop new ways for doing things just to be different but to be different and better. His liking for the high fidelity industry is so great that he has never missed exhibiting in a major audio show since 1951.

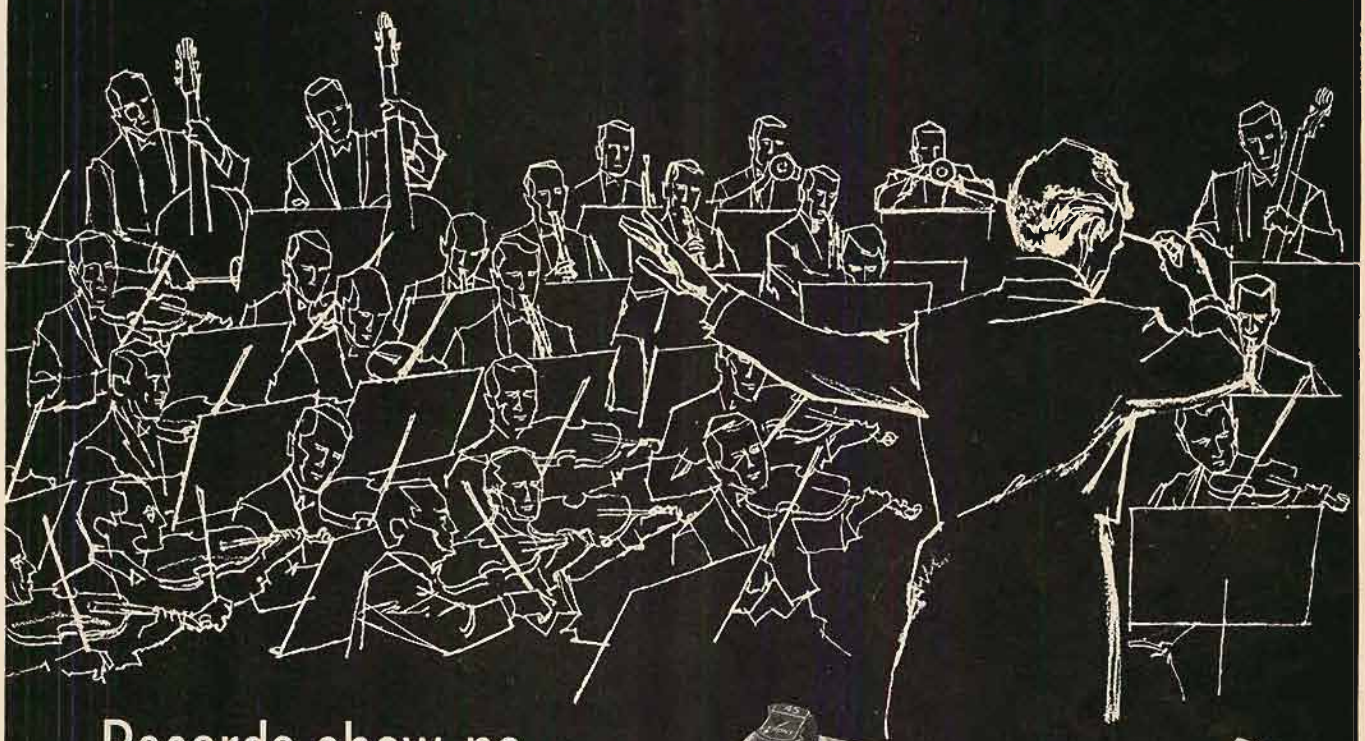
W. W. Wetzel

Dr. W. W. Wetzel, divisional vice president of the magnetic products division of the 3M Company, St. Paul, Minn., helped father the sound recording revolution and has supervised its growth into an industry which impinges on the lives of all Americans.

The 3M Company first became involved in magnetic product development in 1944 when the Brush Development Co., under a military contract, arranged

(*Continued on page 72*)

THE NEW ELECTRO-ACOUSTIC...



Records show no discernible wear, keep their fidelity through hundreds of playings on this unique player.

Tracks at less than 3 grams . . . the 4-speed Electro-Acoustic 7000 series stereophonic record player with diamond stylus is certified to apply less than 3 grams tracking pressure. Your fine recordings show no discernible wear or tonal deterioration even after years of playing. Its laboratory-tested pickup maintains perfect fidelity and incomparable realism throughout the entire recorded range.

The dynamically-balanced 4-pole, 4-coil motor and turntable, the micro-honed motor spindle, precisely machined bearings, and the custom-fitted turntable drive limit rumble to −40 db, wow to less than 0.15% RMS and flutter to 0.06% RMS (better than NARTB standards). Turntable speed is certified to be within ± 1% of absolute. $69.50 Audiophile Net. *Write today for free illustrated literature and the name of your nearest dealer.*

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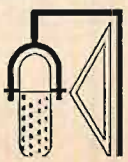

CERTIFIED QUALITY
Each record player is laboratory tested and is sold with a written test report coded to the serial number of that particular record player, certifying that performance is within specification limits.

HERMAN BURSTEIN

Tape is Better Than Ever!

Of the five basic audio components—the others being the phonograph, tuner, amplifier (including preamp), and speaker—the tape recorder is the baby of them all in terms of age and at the same time it is the most complex of the lot. Like the others it is a medium for reproducing sound, but unlike the others it also has the unique function of storing sound. Each of the others is either a mechanical device or an electronic device. The tape recorder is both. Thus it is complex in its functions, complex in that it requires both mechanical and electronic apparatus to serve these functions, and further complex in the coordination of the mechanical and electronic aspects.

In the approximately decade and a half that the tape recorder has been with us, a device of this complexity cannot help but have undergone changes, some under the impact of stereo and others for different reasons. On the whole, these changes have been of an evolutionary sort. There have been no pervading revolutionary developments, such as the introduction and acceptance of FM as a vehicle for high fidelity, or the introduction of the FM multiplex concept. On the other hand, there have been a host of lesser developments which, added together, make the home tape recorder quite a different instrument today than it was some years ago.

Format

In the past several years, the attention of the high fidelity tapefan has probably been most strongly focussed on the question of format, that is, of track arrangement. This has been quite an unsettling question, involving a series of changes that tended to render tape machines obsolete unless subjected to fairly expensive modifications. Fortunately, it now appears that the issue of format has been satisfactorily decided for a substantial time to come.

For a goodly number of years, while all was mono, format was simple and quite standard. Most home machines operated on a half-track basis, as in (A) of *Fig.* 1. After a tape was recorded or played in one direction, using nominally half the tape width (with a safety island to prevent crosstalk between tracks), the reels were reversed by the operator so that the other half of the tape width could be used. If one desired to operate on a full-track basis, it was usually necessary to get full-track heads on special order.

The confusion began with the advent of stereo, which employed tape as a popular medium before it made widespread use of disc and radio. Initially, stereo also operated on a half-track basis, as shown in *Fig.* 2, with the upper track being used for one channel and the lower track for the other. Half-track stereo went through two phases. First, a staggered head arrangement, as in (B) of *Fig.* 1, was used; that is, two heads were employed, spaced about 1.25-in. apart. The gap of one head spanned the upper track, while the gap of the other head spanned the lower track. But this was a cumbersome arrangement, and after a while the in-line head, (C) of *Fig.* 1, made its appearance, consisting actually of two heads within a single housing, so that the gaps were one above the other in a vertical line. The in-line head called for a decided advance in the art of head manufacture, an important part of the problem being to prevent crosstalk between what were in effect two heads in very close proximity.

Hence quarter-track stereo (or four-track stereo as it is often erroneously called) was a natural development. *Figure* 2 shows the quarter-track format. The tracks numbered 1 and 3 are used when the tape is operated in one direction, and tracks 4 and 2 are used in the other direction. While quarter-track stereo solved the problems of convenience and of tape cost per minute of recording, it raised other problems. The narrower track means less signal is presented to the tape playback amplifier, making it more difficult to achieve a good signal-to-noise ratio. Also, the narrower track means there is less chance for tape irregularities to average out, resulting in greater likelihood of such disturbances as dropouts (sudden, brief drops in volume). However, improvements in heads and in tape have gone a long way toward coping with these problems.

The introduction of quarter-track heads has made quarter-track *mono* operation possible, which means putting four instead of two mono tracks on tape and thereby doubling the amount of recording time for a given amount of tape. To take advantage of the possibility, some manufacturers have incorporated the necessary switching facilities in their tape machines so that the user can record on one channel without erasing the second channel.

Even for new models of tape machines, it has not been easy to keep pace with changes in format. Thus today there are still some transitional problems. For example, some machines provide for stereo recording on a half-track basis, while permitting either half-track or quarter-track stereo playback. To alternate between half-track and quarter-track playback, either of two methods is used: (1) A quarter-track head is employed for both modes of operation; (2) two playback heads are employed, one quarter-track and the other half-track. Where only a quarter-track head

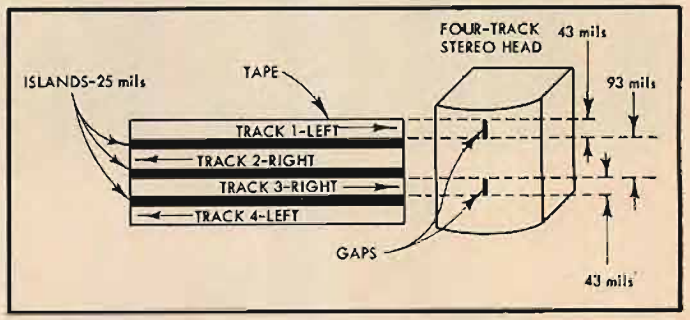

Fig. 2. Four track stereo tape.

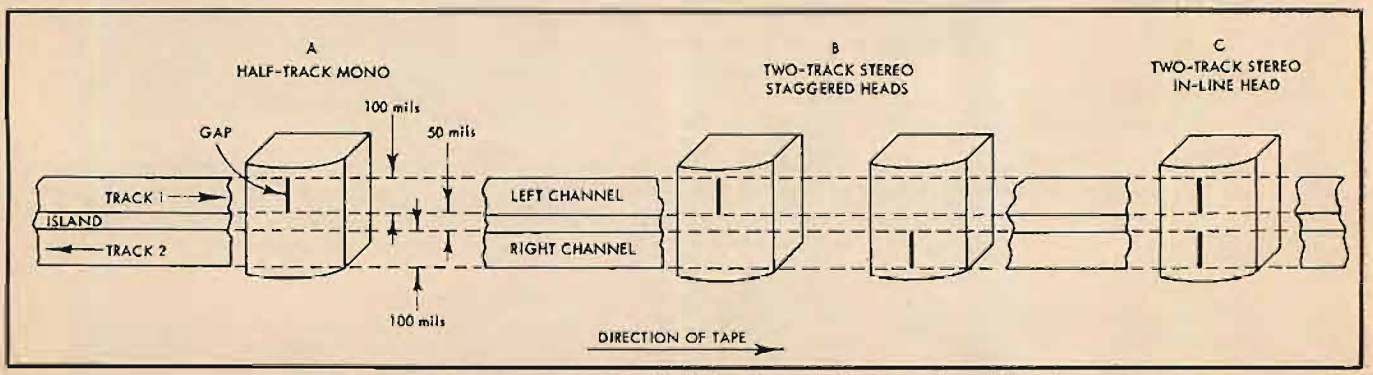

Fig. 1. Head configurations for half-track and mono and two-track stereo tape.

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Now Kodak brings you a new and superior Sound Recording Tape! It gives fully balanced response through the entire audio range . . . and unexcelled voice reproduction. It is the sort of tape you expect only from a company long experienced in precision coating with sensitive emulsions.

New Kodak Tape is unsurpassed for uniformity. The thickness of the oxide layer is held to a tolerance of 14 millionths of an inch! This means you will record and reproduce both highs and lows without distortion.

For years you've saved the sights you love on Kodak film. Now you can save the *sounds* you love on a sound recording tape of equal excellence and dependability. New Kodak Sound Recording Tape comes on a 7-inch Thread-Easy reel with a unique built-in splicer. It's at your Kodak dealer's right now. Try a roll soon.

You can depend on the name Kodak

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EASTMAN KODAK COMPANY, ROCHESTER 4, N.Y.

is employed, some machines permit this head to be shifted up or down, depending on the mode of operation, so that it will span as much of the recorded track as possible in each mode; other machines keep the head stationary to avoid the possibility of azimuth misalignment as the head is moved up or down.

Tape Speed and Frequency Response

The speeds principally in home use are hardly different today than they were almost at the outset of the tape era. The major difference is in the performance, particularly with respect to high-frequency response, attainable at a given speed. Stated conversely, for a given level of performance the speed requirement has been lowered by 50 per cent.

Top quality home machines almost without exception used to offer a speed of 15 ips. Today some do and a number don't, with 7.5 ips being the highest speed of the latter. Taking home machines as a class, 7.5 ips has been the most popular speed for many years. However, the upper response limit used to be considered about 8000 cps at this speed, whereas today 15,000 cps or more can be reproduced at 7.5 ips.

A coupling of the 7.5 ips speed with 3.75 ips has long been popular and continues to be so. Although 3.75 ips used to be derided as a medium for anything resembling high fidelity, today it is taken fairly seriously because it permits response to about 10,000 cps, which is quite good. Inasmuch as today we can do about as well at half the speed of yesteryear, the 1.875 ips speed is coming into increasing vogue. Response to about 5000 cps can now be attained at 1.875 ips, and there are substantial hopes for a still better future.

In sum, 7.5 ips is the accepted speed for high fidelity home tape recording. Virtually all prerecorded tape is made at this speed. Although there was an attempt several years ago to build a market for 3.75 ips prerecorded tape, this effort seems to have fallen by the wayside.

The improvement in frequency response at a given speed is due to several factors, including playback heads with narrower gaps, improved tape oxide formulations, and better mastery by tape machine manufacturers of a rather sophisticated art. The principal factor has been the development of heads with narrower gaps for playback (a narrow gap is unimportant in recording; in fact, a relatively wide gap tends to be superior).

Originally, tape playback heads (or heads for both recording and playback) had a gap about .0005-in. wide, which limited response to not much more than 7500 cps at 7.5 ips. The next development brought heads boasting gaps of about .00025-in., which made playback response to 15,000 cps feasible at 7.5 ips. In the last two years or so, gaps have been reduced to the order of about .0001 in. which theoretically permits playback response to 30,000 cps at 7.5 ips and to 15,000 cps at 3.75 ips.

However, as depicted in *Fig.* 3, certain magnetic phenomena that occur in recording (demagnetization and bias erase) make it impractical to try for 30,000 cps and 15,000 cps response, respectively, at 7.5 and 3.75 ips. This doesn't mean it is impossible to record 15,000 cps at 3.75 ips. But it does mean that undue sacrifices in terms of distortion and signal-to-noise ratio, which are interrelated with frequency response, would be required. On the other hand, it is quite possible that future developments will make it possible to attain at 3.75 ips that which we now enjoy at 7.5 ips, in the same way that 7.5 ips has replaced 15 ips. In fact, on a laboratory basis, response to 15,000 cps along with good performance in terms of distortion and signal-to-noise ratio has been demonstrated at a speed as low as 1.875 ips—but to repeat, on a laboratory basis.

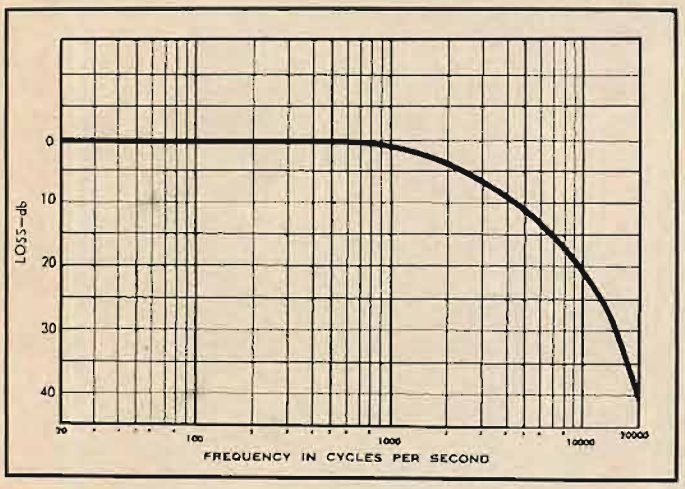


Fig. 3. Typical recording losses in a tape machine operating at 7.5 ips.

Signal-to-Noise Ratio

One area in which home tape machines have shown notably slow progress is signal-to-noise ratio. In part, this is due to the change from a half-track to a quarter-track format, resulting in a signal loss exceeding 6 db inasmuch as a quarter-track is somewhat less than half as wide as a half-track (because of the need for three safety islands instead of one).

A tape of good quality inherently has a signal-to-noise ratio of something like 65 to 70 db at 7.5 ips. This means that a 400-cps signal recorded at a level producing 3 per cent harmonic distortion on the tape will be about 65–70 db above the level of noise due to the tape itself. However, what we ordinarily have most to contend with is not the noise of the tape but of the tape amplifier, particularly the playback amplifier.

The very best home tape machines are able to achieve signal-to-noise ratios of about 55 db on a quarter-track basis at 7.5 ips. True, they could also achieve 55 db years ago, but then it was on a half-track basis. Hence, in relative terms, there has been improvement. Such improvement is due to the development of superior playback heads having high inductance and therefore capable of delivering *relatively* large amounts of signal (in absolute terms, still only a very few millivolts). But these heads are found in machines having separate heads for record and playback—that is, in the better tape recorders.

Motion

In contrast to their generally poor showing in the matter of signal-to-noise, many home tape machines have made amazing strides with respect to wow and flutter. Whereas wow and flutter amounting to 0.5 per cent or more was not uncommon in early units, today a fair number of tape recorders, including some that are quite moderate in cost, fall well within the professional limit of 0.2 per cent. In fact a number of home machines have been credited with wow and flutter less than 0.1 per cent.

On the other hand, exceedingly few home machines have managed to come up to the professional specification that a machine shall operate within 0.2 per cent of exact speed. Most home tape recorders depart from exact speed by 0.5 per cent, some over 1 per cent. Fortunately, most of us cannot detect, and therefore are not bothered by, deviations from correct pitch until they are over 1 per cent, often well over this figure. But those few who have a keen sense of pitch must search carefully for a home tape machine that meets their needs, at least if they plan to play prerecorded tapes. If they plan to record and play back on the same machine, the speed error, if any, will be minimized. (It will be seen in the following paragraph that it is possible for a speed difference to exist between record and playback even though the same machine is used for both.)

It is interesting to note that even home machines with hysteresis motors, which operate at quite constant speed, may have speed errors ranging from about 0.5 to 1 per cent. What these machines lack is precise dimensional accuracy of the capstan and possibly other parts, so necessary for very accurate speed. On the other hand, a hysteresis motor helps ensure constant speed from the beginning of the reel to the end of the reel, between recording and playback, and between one day's use and the next day's use of the tape recorder. In contrast, other types of motors are subject to some speed change with varying voltage conditions and with the changing load on the motor as the take-up reel accumulates tape.

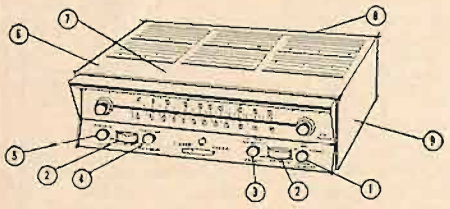
The Tape Cartridge

One of the closest things to a technological upheaval in the tape field has been the introduction of the tape cartridge. The tape is enclosed in a container, which need merely be inserted into the tape machine in order to actuate the latter, requiring no threading or other manipulation on the part of the user. It has been visualized that the cartridge would be particularly apt for prerecorded tape.

However, although the idea has now been around for a few years, it has barely taken hold. A cartridge machine is to be seen here and there, but not enough to constitute the promised revolutionary change. The open reel is still standard for prerecorded tape.

The Magnetic Medium

Initially, home magnetic recorders wrote their message by magnetizing a strand of



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fine wire rather than a ribbon of tape. But wire snarled easily and had certain technical faults (such as twisting and resultant corruption of the magnetic message). It soon gave way to tape, consisting of a coating of iron oxide on a supporting base. At the beginning, the base was generally of paper. But this tore too easily, and a stronger material in the form of cellulose acetate was adopted as a base, eventually supplanting paper completely.

The desire for additional strength plus other characteristics, such as greater freedom from the ravages of age, resulted in the adoption of polyester film—best known under Dupont's trade name of Mylar—as a base for many tapes. The increased strength of the base made it feasible to produce tapes two thirds or even one half as thick and these thinner tapes are respectively known as 1-mil and ½-mil tapes, referring to the approximate thickness of the *base* in thousandths of an inch. Accordingly, it is possible for a 7-in. reel of tape to hold 1800 or 2400 feet of tape instead of the customary 1200 feet. The ultimate result is that a much greater amount of material can be recorded on a single reel. Thus if you can record mono on a quarter-track basis at 1.875 ips, about 17 hours of material can be put on one 7-in. reel of ½-mil tape. If you record stereo on a high fidelity basis—that is, at 7.5 ips—you can still get over two hours of material on a 7-in. reel of ½-mil tape.

Improvements in tape have pointed in other directions as well as greater strength and longer running time. Formulations have improved toward better treble response. Magnetic oxides of greater homogeneity have been developed, eliminating dropouts and serving to keep the recorded level more uniform. Lubricating materials have been incorporated in the tape to facilitate smooth passage across the heads. Special tapes have been developed in order to reduce print-through or to increase the level of the signal recorded on the tape for a given amount of distortion.

The Modular Approach

For high fidelity in general, the modular approach is the one most often followed. That is, you can purchase a separate tuner, preamplifier, power amplifier, and so on, based on the qualities you are looking for in each component. You don't necessarily buy a preamplifier, say, from the same manufacturer whose power amplifier you prefer.

In the beginning of the home tape recorder era, there was no such thing as the modular approach. But within a few years it began to manifest itself. Separate tape transport mechanisms, tape electronics, and heads became available. Here, too, was the thought that the audiofan could assemble those elements which he considered best—either absolute best or best for the money.

But it cannot be said that this trend has made great headway. The main obstacle is matching the tape electronics to the requirements of the heads. This is particularly true in recording, where the amounts of audio and bias current that should be fed to the record head are quite critical and vary from head to head. Also, it is not simple to mount heads of various kinds on a transport. There is no universal mount for tape heads as there is for phono pickups. Aside from the physical problem of how to mount heads of various sizes and shapes, there is the problem of properly aligning the heads with respect to the tape. This is a more difficult problem than aligning a phono cartridge stylus with respect to the disc. The tape heads must be aligned in their vertical relationship to the tape and must also be correctly positioned with respect to the three axes of a head; to make this clear, we can draw an analogy to the roll, pitch, and yaw problems of a sea or air vehicle. Incorrect alignment can result in poor treble response, poor bass response, undue or uneven head wear, crosstalk, and poor signal-to-noise ratio.

To the extent that there has been some success in the modular approach where tape machines are concerned, this is most evident in the case of the separate transport mechanism. It has long been felt that for many audiofans the tape machine would fill a role analogous to the phonograph. That is, it would be used only for playing commercial prerecorded tapes and not for making recordings. Therefore one does find today several transport mechanisms, including tape head, intended for playback only. This includes units of high as well as moderate price. In keeping with the trend, virtually every high fidelity preamplifier or integrated amplifier made in the past several years incorporates an input designed to receive a signal directly from a tape head and to provide the substantial amounts of amplification and equalization required (bass boost).

Equalization

If a tape recorded on one machine (and here we are thinking mainly of commercial prerecorded tape) is to be played back with flat response on another machine, standard playback equalization is an obvious necessity. Although the phono industry has enjoyed the benefits of standard playback equalization for about eight years, such good fortune has not yet visited the tape industry.

Despite the absence of *official* equalization standards for the tape speeds commonly in home use, *unofficial* standards have been taking increasing hold from year to year. The NAB (formerly NARTB) curve, which is official only for 15 ips, has become well entrenched as the *de facto* standard at 7.5 ips. This consists of bass boost commencing (3 db up) at 3180 cps and ending (3 db below maximum) at 50 cps. Unfortunately, for a substantial period of time there was considerable confusion, because a number of tape recorder manufacturers (for sound enough reasons) employed a "modified" NAB curve at 7.5 ips, consisting of bass boost starting at 1590 cps. But most home machines that take their job seriously now provide true NAB equalization, so that a closer approximation to flat response can be had when playing a prerecorded tape.

In the case of 3.75-ips operation, a playback curve has been advanced by an industry committee but has not yet become official. This "suggested" standard has bass boost commencing at 1326 cps and leveling off at 50 cps. Apparently a number of tape machines are conforming to this curve. At 1.875 ips, there is yet no standard of any kind to the writer's knowledge.

Sound-on-Sound

Sound-on-sound has been gaining popularity as a feature of home tape recorders. This means the ability to make two or more recordings on the same track, so that a soloist can turn himself into a duet, trio, quartet, ad infinitum.

The advent of stereo tape machines, providing two separate channels, has given impetus to sound-on-sound because they obviate the need for special facilities. In the case of a mono tape recorder, the special requirements are: separate record and playback heads; location of the playback head *before* the erase and record heads, usually accomplished by having an extra playback head in addition to the one in the normal position (following the erase and record heads); a mixer for combining the playback signal of the first recording with the second recording signal; the two signals are then simultaneously recorded on freshly erased tape.

In the case of a stereo tape machine, even though it employs the same head for record and playback, sound-on-sound is feasible through suitable switching facilities so that the following can be done: play one channel while recording on the other; feed the playback signal to the track being recorded; and mix the old signal being recorded with the new signal being added to the same track. Monitoring the playback of the first recording can be done via the audio system operating at low level.

Reversibility

Probably every tape recordist at some time has been in the predicament of having the tape run out while recording a program off the air. Precious, irrecoverable moments are lost while the reels are reversed, the tape is rethreaded, and the recording is resumed. Hence the desirability of a machine capable of operating the tape in either direction, without the need to reverse reels.

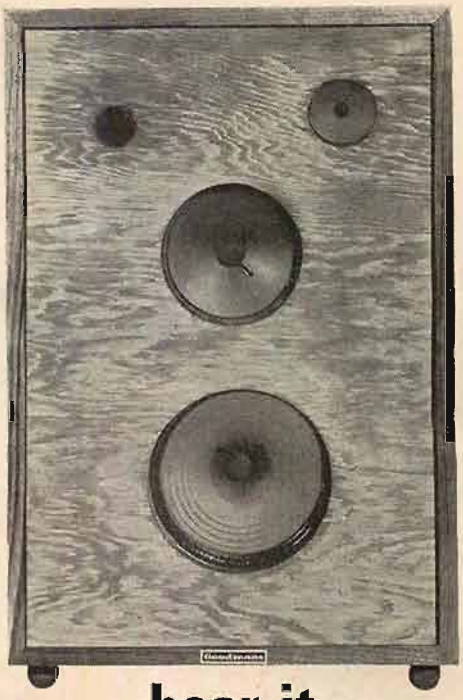
From time-to-time a machine has appeared with this feature. At present one of the top quality home machines features reversibility. But these appearances have been few and far between, and there is no noticeable trend in the direction of reversible operation. The problem is largely one of maintaining as good wow and flutter characteristics in one direction of tape travel as in the other. Best motion is obtained when the capstan and pressure roller are pulling the tape rather than pushing it; thus if the tape normally moves from left to right, the capstan and roller will be located to the right of the heads.

Tape Duplication

A technological revolution long hoped for but not yet in sight concerns tape duplication. A phono disc is stamped "all at once" from a mold. Not so a tape. In essence, a duplicate tape is made by playing a master tape and at the same time recording the playback signal onto another tape.

A master machine plays the master tape, and the playback signal is simultaneously fed to a number of "slave" recording machines that make the duplicates. This involves quite a large roomful of equipment. To speed up the process, both the master and slave machines operate at accelerated speeds (60 ips). Also, all tracks are recorded at once. Still the process is a laborious one compared with pressing phono records, which partly explains why prerecorded tapes are more costly than phono discs. Also, there are technical problems of maintaining consistent results from one tape duplicate to another and from one batch of duplicates to another.

However, progress seldom comes truly to a standstill, and one of these days it may be our privilege to report a vastly improved, less expensive method of tape duplication. Æ



See it hear it

Goodmans new Slimform Speaker system

One of a smartly styled family of SLIMFORM® Speaker systems from Goodmans, the G-1 is living proof of power and performance for a price. Genuine hand rubbed, oiled walnut veneer cabinets are of ¾" stock, acoustically lined, and decorator designed. Traditional British devotion to precision and detail was never more in evidence. All drivers incorporate curvilinear cones for rich, full sound dispersion. SLIMFORM DEKORATOR® cabinets can be used without legs, on bookshelves. Model **G-1:** 8" driver, 6" closed-back mid-range, 3½" high frequency tweeter, crossover network, tuned port, uniform frequency response 40-17,000 cps, 15 watts, 16 ohms, **$56.50.** Model **G-2:** 10" driver, 6" closed-back mid-range, 3½" high frequency tweeter, tuned port, crossover network, uniform frequency response 40-17,000 cps, 20 watts; **$59.50.** Model **G-3:** three 8" driver woofers, 6" closed-back mid-range, 3½" high frequency tweeter, tuned port, crossover network, uniform frequency response 40-17,000 cps, 45 watts; **$79.50.** G-1 and G-3 series SLIMFORM Systems measure 25"h, 17"w, 5¼"d. Model G-2 measures 25"h, 17"w, 6¼"d. See and hear these speaker systems at your dealer now, or write for information. **ROCKBAR CORP. 650 Halstead Ave., Mamaroneck, N. Y.**

The price will floor you...$56.50

. . . what audio will be like in 1977

• In 1955 I published a graph suggesting that logarithm of the stylus force in home phonographs decreased as a straight-line function of time. Linear extrapolation predicted that the 2-gram range would arrive in 1962. By further linear extrapolation, I predict that home phonographs will play with 0.25-gram stylus force by 1977, and Ted Hunt's 0.1-gram prophecy will be fulfilled in ten additional years or by 1987.

• By 1977 magnetic tape technology will have taken substantial strides, and because of improvements in coatings and multi-channel slow speed recording techniques, polyhedron sound recordings (a term especially coined for this issue of AUDIO, denoting sound reproduction from many directions in space) will be attempted and will gain a measure of popularity. I doubt that they will displace mechanical means of recording and reproduction which have shown amazing ability to rebound when their commercial fate was endangered.

• Prior to 1977 we should see some radical improvements in loudspeakers. The present method of moving external air with a heavy cone while at the same time compressing the internal air in a box is like swatting flies with a sledge hammer. Electrostatic and similar wide area loudspeakers will find universal use. Dipole and phase-shift loudspeakers will come into their own. Means for reproducing stereo from proximate loudspeakers will have been perfected.

• The popularity of personal listening devices will increase and they will provide stereophonic reproduction by wireless.

• Electronic means for controlling the acoustics of listening rooms will be widely used. No longer will the listener be at the mercy of interior decorators for his musical enjoyment.

• High fidelity will be within the economic reach of everyone.

Ben Bauer

• I believe that the gramophone record and pickup will *not* be replaced for domestic use by any form of tape or scanning system, because of the ease with which you can pick up a disc, read the details on jacket or center label, and then play the movement or item you want to hear. It should also be remembered that modern records and pickups are pretty good.

• I also believe that the moving-coil speaker will retain its lead at the end of the reproducing chain, due simply to physical dimensions and the laws of nature. Most people want maximum performance in minimum space, and the moving coil is the only device which will provide the movement necessary for good low-frequency output in 1 or 2 cu. ft. The flat diaphragms with possibly superior driving coverage unfortunately require 5 or 6 sq. ft. of area for full-range output.

• As to the future of the hi-fi industry in general, I think this is assured by the very high quality of the individual components now available. Modern turntables, tone arms, pickups, tape recorders, amplifiers and speakers justify freedom of choice and preclude the one-piece, packaged furniture approach. An á la carte meal may cost rather more than a set table d'hote, but in hi-fi it is worth it. And the speakers *must* be kept acoustically separate and not made into a plum pudding by being mixed up with the other ingredients.

G. A. Briggs

• Future trends are already apparent; greater compactness made possible by transistors and more advanced applications of old principles in speaker design: some "picture frame" speakers are already available. With the continued development of electrostatics and their counterparts, the distributed-coil dynamics, perhaps speakers will become *completely* concealed in tomorrow's rooms. Who knows but that they will be bought by the square yard, or even by the roll, like wallpaper—and used similarly? But that is only the next step. Later on it should become quite feasible to transform electrical signals to sound directly just as we are now beginning to generate electricity from heat by means of magneto-hydrodynamics, thermionics, and thermo-electricity. (The ionophone principle, already in use, is in this class.)

• Even this does not seem to be the ultimate. Why not excite the auditory nerves directly? A simple operation at an early age may be carried out to install a tiny microcircuit that will permit one to hear radio and recorded signals without any loudspeakers or earphones at all. Here would be the ideal way to eliminate the plaguey imperfections of these devices. Think of hearing really perfect reproduction—and at any desired volume, without disturbing one's neighbors, or even someone close at hand! And what separation for stereo!

• As to amplifiers, tuners, record players or tape units, these may well *disappear* from sight *altogether*. Stored in some concealed spot—a closet or a *cellar*—they will respond to spoken commands, and perhaps finally even to thoughts. In the latter case they should incorporate a time-delay device for people who can't make up their minds, to prevent uncontrolled oscillations.

Vic Brociner

• Transistors have not yet been extensively applied in audio. All initial work with transistors suggests that *basically* they have every advantage over tubes for most spots in an audio system. We should soon be seeing a far greater proportion of transistor units, with improved performance over the tube types.

• I also expect to see a successful velocity radiator—a sort of inversion of the ribbon mike, but using some completely new principle—to give much more control over the radiation of sound waves than existing systems give. This, together with the development of satisfactory servo-feedback systems, including the radiator (or loudspeaker) in the feedback loop, will advance fidelity to a degree that will make present standards seem crude, to the more refined ears, at least.

• Electronic organs for the home have already started a strong upsurge. Riding the tail of electronic organs will be other electronic musical instruments that will be capable of synthesizing musical sounds of all kinds, and creating many new ones, by means that anyone can use with only a little practice. The techniques and circuitry that have been developed for high fidelity will provide the core of these developments, but a lot of new things are needed to complete the picture in the next fifteen years.

Norman Crowhurst

• One of the fascinating parts of the audio business is that there is still great room for improvement. This improvement will follow two lines: one, the year-to-year improvement of existing devices. Phonograph pickups will be improved and will track at well under one gram. This will require the development of new types of arms, methods of lowering and raising the pickup to and from the record. Loudspeakers will be improved and more and more attention will be given to the definition characteristics of music rather than to distortionless sine wave reproduction. There is still room to improve the whole electronic chain of sound reproduction.

• Looking way ahead, the biggest improvement that will come will be the combination of sight and sound. No one would go to a movie today without a sound track. Likewise, for the greatest realism, all sound should be accompanied by the pic-

ture. Probably the sight and sound will be built into large, shallow frames attached to the wall of the room.

• There will be new approaches to the storage of both sight and sound information and with the active search for better methods of information storage (more bits of given information in a given area), there will undoubtedly be a *new medium used for reproduction*. Magnetic tape is being tremendously improved but there are many other ways of storing information.

• With higher and higher switching rates, possibly using transistors now being developed, probably a lot of our audio will be controlled, at the output, by rapid switching. New types of coding both sight and sound information will come into being and a wider use will be made of pulse code.

Sherman Fairchild

The audiofan of 1977 will enjoy:

• Voice-activated controls.

• Miniaturization based on smaller components, modular construction, the use of transistors, tunnel diodes, and printed circuit boards; and micro-modules. There will be a trend toward the use of ceramic wafers —with transistors, capacitors and interconnecting leads (and eventually diodes and transistors)—printed on these wafers.

• Because of the small control panels resulting from the above developments, certain functions will be eliminated and replaced by automatic adjustment to the needs of the acoustic environment in which the equipment is used. First to go will be tone controls.

• Large dial scales will be replaced by digital frequency indicators.

• Loudspeakers will be of the flat type, probably wall-mounted.

Avery Fisher

• The next fifteen years should be just the right amount of time to concentrate on what would appear to the most important problem in the field of audio: to render music reproduction in the home truly realistic. Since we already have developed superb components, the next step should be the determination of what the listener at home is supposed to hear. Rarely do we get the illusion of hearing the music performed as intended by the composer; he counted on his symphony or concerto being performed in a concert hall. For the home, he wrote chamber music.

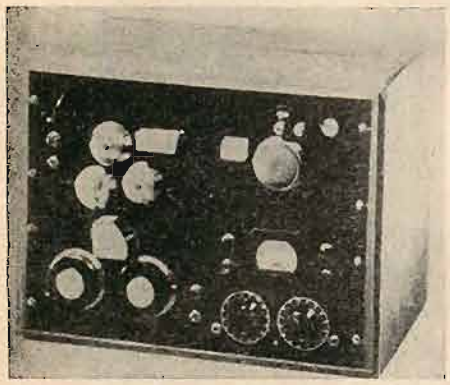
• It may be a good start to drop the "high" from high fidelity. Fidelity should signify the reproduction of the original music quality from a record or tape in the living room with complete reality. This sounds like an impossible task, since the performance of a 90-piece orchestra in Carnegie Hall can hardly be duplicated in a 15 × 20 ft. room without causing physical and mental anguish to the listener. What then is the most realistic effect that can be derived from the recorded composition? Since fidelity of loudness is impractical, the sensation which can be reproduced in the home is that of distance or perspective rather than proximity. Imagine sitting in the rear of the auditorium far away from the orchestra. This is a sensation familiar to most of us and does not detract from the enjoyment of the music—on the contrary, many people prefer to listen from such a distance. A large proportion of reverberated sound and relatively little stereo effect is heard under such conditions. These are factors which can more readily be reproduced in the home, thereby creating an illusion less dependent upon specific components than on meeting the acoustic conditions just spelled out. The execution of this approach begins with the proper recording conditions

(*Continued on page 78*)

~~NEW~~ Old PRODUCTS

• **High Fidelity Recorder.** A high-fidelity wire recorder which incorporates the principles developed in recent years by the Armour Research Foundation of the Illinois Institute of Technology was announced recently by Magnecord, Inc.

Designed for professional users, the Magnecorder Model SD-1 has a frequency response rated flat within 2 db from 50 to 12,000 cps with a signal-to-noise ratio of well over 45 db.



The recording medium for this custom-produced unit is stainless steel wire .004 inch in diameter. However, the unit utilizes a capstan drive system to drive this wire across the heads at four feet per second. This design assists greatly in the elimination of wow and flutter and produces constant wire speed.

Using standard size spools, the Magnecorder is capable of recording and playing back continuously for a half hour.

The unit performs a wide variety of services in the average radio station, is capable of synchronization for motion picture production use, and is suitable for laboratory use. **(May, 1947)**

• **Scott Amplifier.** The dynamic-band-pass principle reaches new peak of performance in the Type 210-A laboratory amplifier. This unit, supplied with a matched variable reluctance pickup cartridge, provides a complete phonograph system except for turntable or record changer and loudspeaker. The amplifier provides 20 watts output with less than 2 per cent distortion, and below 8 watts, the distortion is under ½ per cent. The output transformer is arranged to match speaker impedances between 2 and 500 ohms.

The maximum frequency range of the amplifier exceeds 20,000 cps—with the Dynamic Noise Suppressor the response is flat to 10,000 cps and extends to 16,000 cps. Independent tone controls allow boost or attenuation at either end of the frequency range. A whistle filter is provided for AM reception. In addition to reproducing phonograph records, the amplifier may be used with any standard tuner. This amplifier was designed to provide the best possible reproduction of phonograph records, FM, or AM. **(February, 1948)**

• **New Dynamic Microphone.** Through the use of the new Acoustalloy diaphragm developed by E-V engineers, the Electro-Voice Model 630 dynamic microphone now provides high fidelity pick-up and reproduction of voice and music, suitable for a great variety of applications. Frequency response is substantially flat, 40 to 9000 cps. Output level is 53 below 1 volt/dyne/cm², open circuit. Voltage developed by normal speech (10 dynes/cm²) is .0224 volt. The new Acoustalloy daiphragm withstands high humidity, extremes of temperature, corrosive effects of salt air, and severe mechanical shocks. This makes the Model 630 Microphone especially rugged for indoor and outdoor use. Alnico V and Armco magnetic iron are also utilized in a non-welded magnetic circuit. **(May, 1947)**

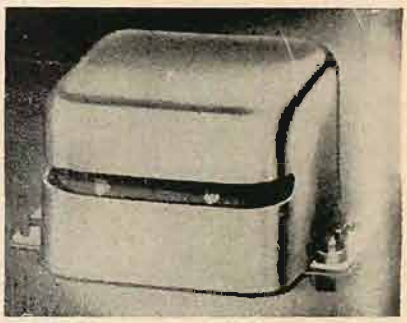
• **Rek-O-Kut Console.** A beautiful new console (transcription or recording cabinet) is being shown by the Rek-O-Kut Company, New York City. This cabinet is sturdily built, being made specifically to mount the various Rek-O-Kut recording and transcription turntables. It has a drop-front door and self-contained pockets for holding approximately 100 sixteen-inch records. The console is finished in a metallic two-tone grey—dimensions 32" high by

24" wide and 25" deep. Outlets and terminal blocks for motor line and pickup are mounted on the motor board. Four screw jacks are provided for leveling the console. The entire unit can be sold separately or in conjunction with any of the regular Rek-O-Kut transcription or recording turntables. **(July, 1947)**

• **Shure Wire Recording Heads.** These new recording heads have the following features:

1—Versatility of playback and recording circuits.

2—Variety of impedances for individual needs.

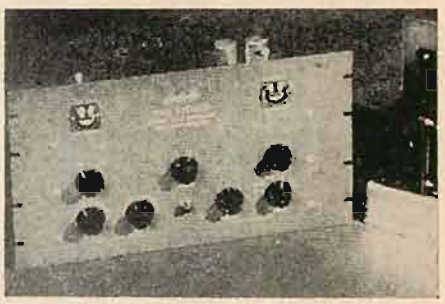


3—Closely controlled air-gaps for uniform performance and excellent wear characteristics.

4—Reduction of hum pickup.

5—Controlled groove contour for minimum effective position of recording wire. **(February, 1948)**

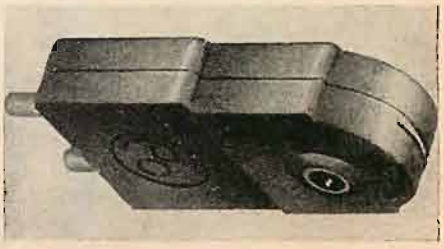
• **Fisher Amplifier.** The new Fisher Dynamic Noise Suppressor-Wide Range Amplifier features 20-watt output with less than 1 per cent distortion. Response is rated uniform within 1 db from 20 to 20,000 cps. The phono circuit is compensated for use with the new magnetic pickups made by G. E. and Pickering. Equipped with bass and treble controls, as well as

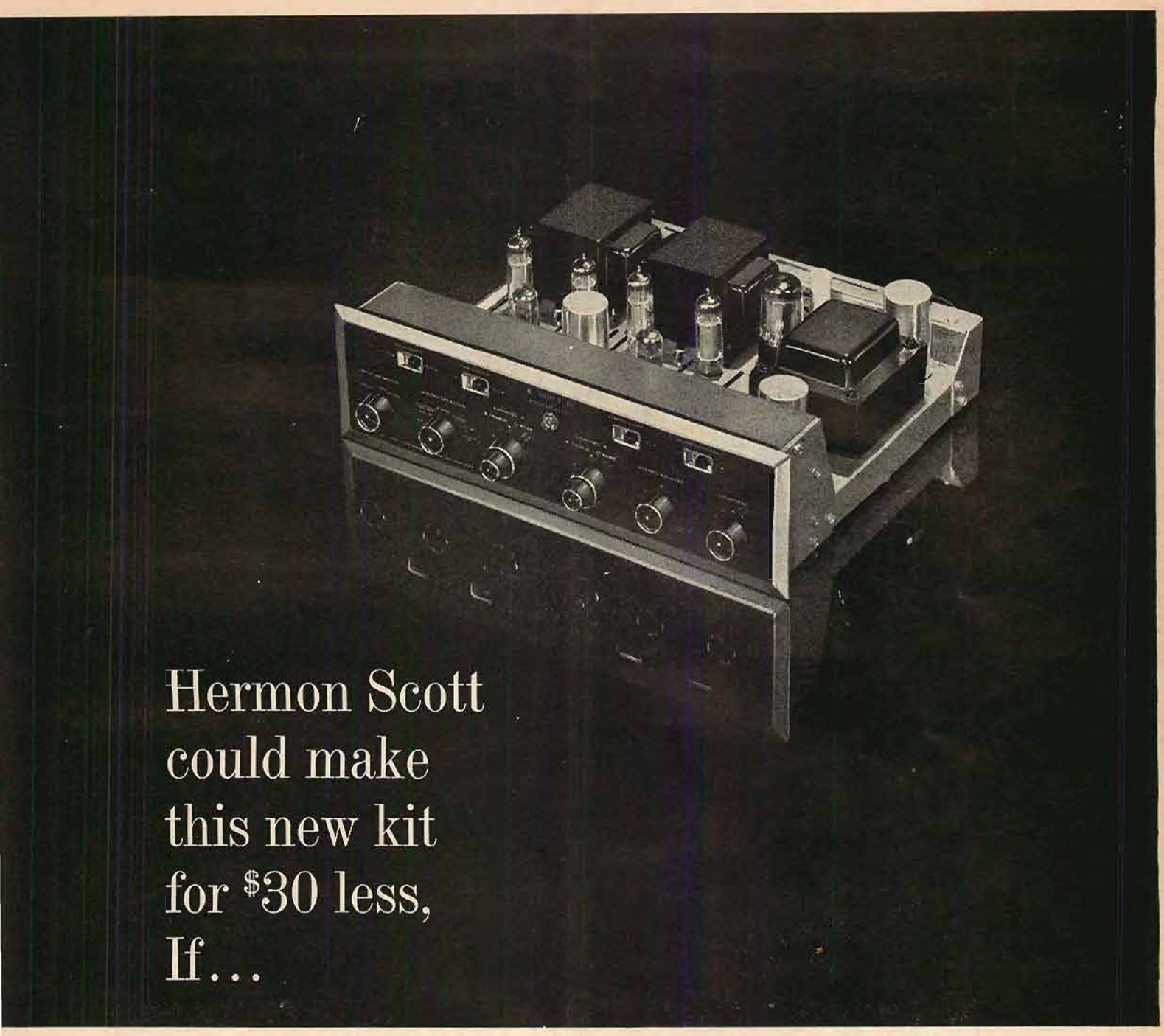


means for regulating band width, and noise suppression.

This amplifier uses the following tubes: 2–12AT7, 1–6C4, 3–6BA6, 1–6AL5, 1–6AQ6, 2–6E5. Licensed under Hermon Hosmer Scott patents pending. **(June, 1948)**

• **Pickering Cartridge Reproducer.** Bringing the advantages of the Pickering Pickup to the user of conventional record players and changers, the Pickering Cartridge is now available at most distributors. The moving system which generates the electrical signal is identical in construction to the Pickering Pickup which has been so successful in the highest quality reproduction of phonograph records and lateral transcriptions.





Hermon Scott could make this new kit for $30 less, If...

Hermon Scott faced a basic choice . . . bring out his new LK-48 amplifier kit at $124.95 or make it to sell for $30 less like many other amplifier kits. All his engineering department had to do was make a few compromises.

The LK-48 is rated at 48 watts. By using a smaller power supply, ordinary output transformers, and pushing the output tubes to their limits, the amplifier might still produce 48 watts at 1000 cycles where many amplifier kits are rated. But measured at 20 cycles, where Scott engineers feel power is really important, output would be down considerably. No compromise was made. The LK-48 *actually* produces 28 watts per channel at 20 cycles, and delivers full power throughout the audio range.

Many kits use a one color instruction book. Hermon Scott decided to continue to use full color to insure factory-built performance, even at the hands of a novice.

Important Scott engineering extras like the all-aluminum chassis, DC operated preamp heaters and unique hum-null balancing could have been eliminated. Hum would have been audibly higher and distortion at levels normal to many kits, but Hermon Scott felt that the kit builder was entitled to the same performance he has come to expect from Scott factory-wired units.

Yes . . . Hermon Scott could have made the LK-48 to sell for $30 less . . . but it would have meant compromising life-long standards. This is something he would never do. You can choose any Scott kit with complete confidence — the LK-48, the LK-72 80 watt complete stereo amplifier, the LK-150 130 watt stereo power amplifier, the LC-21 professional preamplifier, the LT-110 multiplex tuner, LT-10 FM tuner or the LM-35 multiplex adaptor. These superb kits have all the features and performance you've come to expect from the world's leader in audio engineering.

H.H.SCOTT

H. H. SCOTT INC., 111 Powdermill Rd., Maynard, Mass. Dept. 035-05

Please rush me your new full-color brochure telling about Scott's full line of superb stereo kits.

Name.....

Address.....

City.....*State*.....

Export: Morhan Exporting Corp., 458 Broadway, N.Y.C.
Canada: Atlas Radio Corp., 50 Wingold Ave., Toronto.
Prices slightly higher West of Rockies.

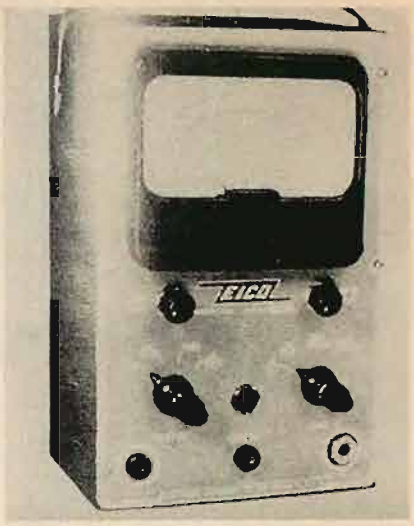
A unique mounting, the keystone clip, attaches to any standard pickup arm, and the cartridge slides firmly onto the clip, permitting longitudinal adjustment for minimum tracking error. The cartridge has a sapphire stylus with a tip radius of 0.003 in., considered ideal for reproduction of shellac records. The output, at approximately 50 mv, is designed to be fed to the grid of a tube.

A simple circuit provides a 12-db/octave rolloff above 4000 cps, when desired, for reduction of surface noise. **(July, 1947)**

• **Electronic Volt-Ohmmeter.** Eico announces another addition to their line of test equipment the Model 221 Vacuum Tube Voltmeter.

A completely new and modern approach in designing vacuum tube voltmeters makes this an exceptionally high quality utility instrument at an unusually low price. Its amazing performance sets standards of accuracy, linearity, and stability, with a coverage of wide ranges and applications heretofore not usually available in this type of instrument.

1. Completely electronic on all functions and ranges.
2. Electronic a.c. range is more linear and accurate than was ever possible with a copper oxide rectifier. More accurate measurements can now be made over a wider frequency range.
3. *The meter can not be burned out.* This automatic overload protection is only possible because of its all-electronic circuit.
4. Special type electronic bridge circuit practically eliminates all zero drift short warm up period.
5. Accuracy is 2 per cent on all ranges.
6. Each instrument is individually calibrated.
7. Twenty-six (26) megohms input resistance.
8. Electronic a.c. and d.c. ranges 0–5, 10, 100, 500, 1,000 volts.
9. Electronic ohmmeter measures from 0.2 ohms to 1,000 megohms on five ranges.



10. Wide range db scale.
11. Stable on all ranges, due to carefully designed compensating circuit.
12. Complete instructions included with every instrument.
13. Large 4½" meter with 2 per cent accuracy.
14. One single linear scale for both a.c. and d.c. measurements. **(June, 1948)**

(Continued on page 95)

PIONEERS

(from page 60)

with the Minnesota firm to develop a thin tape coated with a ferro-magnetic powder.

The company, with its long history of producing adhesives, soon developed a binder. In 1946, 3M, deciding that the key to the future of magnetic recording would be a superior oxide, set out to do just that.

That decision brought Wetzel, then head of the physics section of the company's central research division, into the program.

By 1947, Wetzel's research group had developed a black oxide product on a paper backing. Later that year, 3M produced the first plastic-backed tape. The extremely smooth acetate surface was a decided improvement over the comparatively rough paper surfaces used previously.

Continued experiments led to the development of a superior magnetic material—a red iron oxide. It made possible high fidelity recording at slow

tape speeds, providing good frequency response and more uniform signal output. It also was easily erasable.

With this tape, 3M contacted machine manufacturers and interested them in designing low-cost, slow-speed recorders. The company went into full production and started marketing the tape—the now-familiar No. 111 "Scotch" brand.

However, as frequently happens in research, there was an ironical twist to the discovry. When Wetzel and coworker, H. K. Smith, moved to patent oxide, they learned that an application had already been filed for patenting the same product by Marvin Camras of Armour Research Foundation. Subsequently, the Foundation licensed 3M to produce the oxide.

The revolution was completed in the spring of 1948 when ABC radio used the new tape to pioneer delayed broadcasting during daylight savings time periods. That launched the professional use of tape by the entire radio, recording, and motion picture industries.

Dr. Wetzel is a member of the American Association for the Advancement of Science, the American Physical Society, and the Society of Exploration Geophysicists. He is a Fellow of the SMPTE and an Honorary Member of the Audio Engineering Society.

Thomas A. White

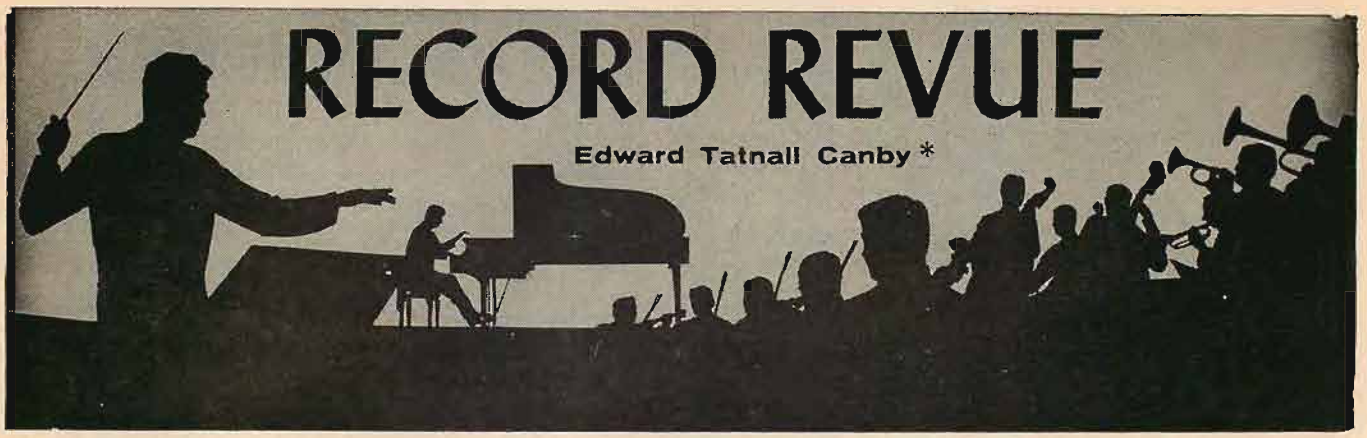
Tom White joined Jensen as Sales Manager in 1928. He was instrumental in the thirties in introducing the first line of component hi-fi speakers, including woofers, tweeters, and multiway systems that were widely available through distributors. He traveled extensively in the period prior to World War II and established foreign distributors and manufacturing licensees.

Specialization in the engineering and manufacturing of the more complex types of loudspeakers brought Jensen

the assignment of major supplier of speakers to the armed forces during World War II.

Mr. White became Vice President of Jensen in 1940, President and General Manager in 1945. When Jensen became a division of The Muter Company in 1950, he was named a Vice President of that company. Under his leadership Jensen has become, in sales, the worlds largest producer of loudspeakers.

Tom White has been active in the administrative and committee work of Electronic Industries Association, serving as a member of its board of directors from 1943 to 1949.



RECORD REVUE

Edward Tatnall Canby *

1. FIFTEEN YEARS AGO . . .

(*Records*—fifteen years ago? I don't have any left. Well, hardly any. After a long search through my shelves I did find the following, received by me for review in July, 1947, just two months after we began operations at AUDIO ENGINEERING. It was a lucky find, because it represents the very topmost advance in 78-rpm recording as of that date, a year before Columbia launched the LP plastic disc.)

Stravinsky: The Fire Bird Suite. London Philharmonic, Ansermet. Decca ffrr London EDA 30 (3 78's).

How these old shellac discs take me back! This was one of the earliest batch of Decca ffrr records—still not officially named London—that caused such a sensation here in the postwar years, when things had at last begun to move again after the long war-time freeze and the slow reawakening in 1946. Anybody who bought records back then will remember the excitement over the new ffrr discs. Fantastic!

Well, as of today, they remain "fantastic." Listening to these short sides—and ironically, I had to pull out an old 78 pickup of the very early 1950's to do it—I can see now how inevitable was the LP revolution. These records have everything *except* the vital LP essentials that were crying for introduction to take advantage of the dramatic new recorded quality. Long play. A tighter, more accurate groove with drastically improved sound in the inner groove spirals. Most of all, a hiss-free record material that would let through the newly uncovered highs.

The recording, to this day, fifteen years later, sounds typically ffrr. Cut a 1962 ffrr recording on 78, press it in shellac, and you'd have a sound much like this, from 1947. A full, wide tonal range, unbelievable to us in those days of the 5000-cps cut-off. An only mildly edgy top end, at that. (Could be due to the combination of the gross 78 groove, wide-bottomed, and my not-so-compliant 78 pickup.) A gorgeous, thoroughly modern-sounding microphone technique with big ffrr liveness. Huge dynamic range, from scratchy-loud all the way down below the loud hiss. Golly, was the old shellac a limited medium for such fine new material! No question about it, the 78 was radically outdated in 1947 as a final vehicle for recorded sound.

The shellac hiss for ears now unaccustomed to it is astonishingly loud, given a correct wide-range equalization. But at least, these Decca ffrr records were smooth, without annoying swishes to pound out the 78 rhythm. That was a much-prized quality, this silky smoothness of loud hiss, as I remember.

I note in particular side 4 of this set, which contains the Lullaby. It is one of those noble efforts of wishful thinking that the recording people were obliged to produce in those days—well over four minutes of loud, continuous shellac noise, through which one can hear faintly the subdued tones of the Lullaby music, gradually dying away. The last half-minute or so is completely inaudible, except for some faint wisps of tone here and there. A lullaby lost in a steam bath.

True, if you knew the music, you could piece together its sense via a good imagination. We all did. But Oh—for a *silent* record material! How could hi fi be hi without it? We'd even settle for a passel of pops and clicks, if only this eternal hiss could be removed.

That was the state of the recording art when we started our RECORD REVUE in 1947. Small wonder I spent most of my first pages prophesying a big future for the *plastic* phonograph record! (See our Tenth Anniversary, AUDIO, ETC, for May, 1957.) Plastic was our only hope for hi-fi recorded sound.

Tape? Who'd heard of tape in 1947. Had you?

2. TEN YEARS AGO IN RECORDS

(Note: My private celebration of our Fifth Anniversary is explained in this month's AUDIO, ETC. Here are some brief remarks concerning a few of the 1952-style records I re-played in my reminiscent survey, as heard on 1962 stereo equipment and from the vantage point of a 1962 listener.)

Borodin: Symphony No. 2. Stravinsky: The Firebird. Minneapolis Symphony, Dorati. Mercury MG 50004.

This is one of the first "Living Presence" discs, the fourth in the "Olympian" series. As of today, it is remarkably clean-cut in sound and the surfaces are good, too. (The old flat edge feels strange under the fingers—RCA hadn't yet introduced the raised-edge LP shape.) What is most noticeable is the astonishing lack of liveness, by present standards. Positively closet-like! The famed one-mike technique, too, (Telefunken) makes for a rather distant effect, lacking in presence. The multiple stereo mikes of today have changed our expectations in this respect. The record plays best on the old Columbia setting (NAB), or at RIAA with the highs rolled off somewhat on the tone control.

Dvorak: Nature, Life and Love; Notturno. (Four works for orchestra.) Vienna State Opera Orch., Swoboda. Concert Hall CHS 1141.

In mid-1962, this one makes me shed a tear for old Concert Hall—I miss the label, I must say. In 1952 I was enthusiastic about the "fi" on this one—I see what I meant, though technically I was wrong; for there is a large amount of steady distortion in the sound, very likely the result of fancy "jiggering" for exaggerated presence. Concert Hall was famous for that sort of thing.

What *is* good, aside from the excellent music, very nicely played, is a really striking sense of presence and aliveness. No doubt about it—this company knew how to take down sound with a more-than-concert-hall illusion. It's a paradox that some of this illusion is, indeed, due to probably deliberate distortion of the mid-range and highs. Given a bit of ear-tolerance, as we all had in 1952, the effects are musically acceptable.

Typically, the record will not play with really adequate tonal balance on any equalization position I have available. Too much distortion. (Boost the highs and it really screams.) I still love it.

Strauss: Oboe Concerto (1945); Violin Concerto (1881). Ertel, Borries; Symph. Radio Berlin, Rother. Urania URLP 7032.

This is one of the musical prizes in my record collection, two unusual Strauss works, composed more than a half century apart, in excellent performances. Records like this are timeless from a musical viewpoint, 1952 or no.

As to the fi—the recorded sound is, from our point of view, remarkably well miked, with a good liveness and presence for mono, the solos close but well integrated into the orchestral sound. This is a typical Urania, as I remember, and it has a well-remembered tonal quality, too, a species of slight sore throat, so to speak. Continuous grainy distortion, no worse in the loud parts than the soft, which in itself is unusual.

The explanation, I suspect, is that this is probably one of those early German Magnetophon tapes that originated during the 'forties, mostly, and were bought up for use in the U.S., in part as the spoils of war. The distortion is not in the disc cutting but, I strongly suspect, in the master tape itself. All the early Uranias had it, few of them bad enough to spoil good listening.

For music like this, I'll take the distortion gladly, even today in 1962.

Tati-Tati—Symphonic Paraphrases on "Chopsticks." Columbia Symph., Janssen. Columbia ML 4480.

No special alphabet label for Columbias in 1952. Then, as now, they were just plain Columbia Records. But this one is really quite remarkable, after ten years. The sound was not then of a spectacular sort, as I remember, yet today it is more modern than almost any other I've tried, including the Mercury "Living Presence." By today's standards it is, to be sure, moderately lacking in liveness; the music, nevertheless, is broad and massive, the orchestral presence unusually immediate. Four years after LP's beginning, Columbia obviously was still top dog.

This is about the cleanest 1952-period record I've tried, too. You can turn your high tone control all the way up and there isn't a trace of unpleasantness in the sound.

"Tati-Tati" is a wonderful collection of elaborate nonsense and should be done again, in stereo. Fancy variations on chopsticks by a battery of well known Russian composers of the late Nineteenth century.

Brahms: Double Concerto, Op. 102. Milstein, Piatigorsky; Robin Hood Dell Orch., Reiner. RCA Victor LM 1191.

A real old-fashioned RCA Victor, this one, complete with prize solo attractions out of the RCA stable, as always. It is an excellent performance, equalled only, perhaps, by the earlier (78) RCA version with, if I'm right, Heifetz and Feuermann, Toscanini conducting.

No wonder these 1952 discs were always scratched up when we got them! Flat as a pancake, no raised edge or center to take the weight off the grooves, and no inner sleeve at all. Improvement in this respect is immense today.

The RCA 1952 sound is, again, surprisingly

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close-up and dead (though not as dead as the Mercury "Olympian" sound from Minneapolis). A chamber-music orchestral sound, very clear in detail but without much over-all ensemble and very little "hall presence." The two soloists are close and very loud, as was the then universal miking style—each, violin and cello, is as big as the whole orchestral accompaniment. Thank goodness, we've moved today towards a more natural balance of solo versus orchestra, mainly thanks to stereo and the need for spatial placement of the soloist in the orchestral picture.

RCA's discs evidently didn't yet have variable groove spacing—no need for it here—and the grooving is relatively shallow as compared to later RCA cuts. There is throughout a faintly noticeable trace of metallic edginess to the sound, which, my ear suggests, is likely due to the disc cutter. This was the time when dramatic new improvements in disc cutting were coming in, RCA doesn't seem to have got there at this point.

Rimsky-Korsakoff: Coq d'Or; Capriccio Espagnol. French Nat. Symph., Desormière. Capitol P-8155.

Arensky: Vars. on a Theme by Tchaikowsky. Grieg: Holberg Suite. Harold Byrns Ch. Orch. Cap. P-8158.

Very early FDS recordings, these—the Rimsky disc had the FDS label hastily stuck on the cover, a sort of afterthought, and neither disc says FDS on its label face. (By P-8163 the FDS insignia had reached the label, too.) This suggests that the FDS full-dimensional sound was a fairly sudden innovation, of a technical nature, having perhaps more to do with the final processing of the music than the actual microphoning at the source.

These two early FDS examples are surely good recordings though the sound is not yet uniform and the effect of the two is actually quite different. Atrociously bad surfaces, the pops and bubbles visible to the eye, all over. The string orchestra recording seems to vary in sound from side to side, the Grieg somehow duller than the Tchaikowsky, with not much in the way of highs and the sound only moderately clean. The Rimsky-Korsakoff is so well miked that it seems to be a better, cleaner recording, worthy of the new FDS designation as the first record is not. But it's hard to tell—the difference may be less than it appears, for massed strings are always tough to record, with their enormously complex acoustic intermodulations and their brilliant overtone coloration.

AE

AUDIO ETC.

(*from page 14*)

heard ultra-close or at a distance. It works—across the board. Even when the new discs are played in mono form.

Stereo has been the big fructifying influence. But its needs, and the results of the stereo experience in recording, have been reflected into the mono sound too, and into the ears of mono listeners.

The Quality Burst

Having expounded upon the more intangible effects of our present recorded illusion, I must not pause without suggesting, too, that the over-all excellence of 1962 recording depends a good deal upon purely technical progress. I found that some of the 1952 records I tried were astonishingly well recorded, amazingly clean in sound—and I noted that a few were pressed on plastic very nearly as quiet as that which we think of as standard today, in spite of the then-persisting barbaric use of unshielded cardboard covers, minus any sort of inner protection for the record.

Comparing the 1952 discs on my 1962 playing equipment with an assist from memory, I note that 1952 was the great LP year of the quality burst. It was that year, (well, 1951–52 if you wish), that saw the fruits of the preceding frantic conversion to LP, going on since June of 1948, finally come to the fore. It took that long for the sound engineers and the other technicians to catch up and forge ahead—it always does.

We must keep in mind that while the engineers worked behind the scenes to improve the LP process in all its enormously long chain of complexity, production had to be kept going with existing equipment—or else. No time to stop for conversion. Improving LP was then like rebuilding a railroad which must continue to carry heavy traffic. The backlog of ready-to-use improvements gradually got larger, through those early years of LP, until in this period I'm discussing, ten years ago, a big dam seems to have broken. Everybody and his brother came out with dramatic new sound, putting all their technical eggs in the new baskets.

The publicity people just about went crazy. And what they said, as happens too often, merely confused the issue in a generally favorable way. They talked jargon; the engineers put out real stuff. (Publicity can't admit to any inferiority in the past product—so the new one *must* be described in generalized terms!)

So, around that time, we had Living Presence, and we had Full-Dimensional Sound, and we had Natural Balance. (Full-Frequency-Range-Recording didn't bat an eye; off in London progress just went on as usual, though *ffrr* had started the rush to fancy initials a good many years be-

fore.) If I've skipped a few brand-names, it doesn't matter, They all sound alike, really, and their public claims to fame were equally vague when it came to concrete facts. But they were good.

Cutter Heads

After listening awhile to 1952 quality variation (the records I chose were released more or less at that time, and undoubtedly represented the actual work of the last several years, culminating in the brand-new "initial" recordings of then recent date)—I began to pinpoint the *recording cutter* as maybe a major factor, in what I heard. Now this I cannot confirm; but (you recording engineers)—wasn't it in this period that really satisfactory wide-range microgroove cutters, a "second generation" of them after the semi-improvised first ones, began to come into use? Wasn't the new quality splurge based first of all and 'way down deep on improved cutting heads, with the use of hot-stylus cutting (haven't checked on the date of that innovation)?

I'm reasoning thusly because, as I reconstruct it, the other elements in the long chain were much less crucial—subject to more gradual improvement. Yes, there was rumble from cutting tables. There was hum, often present. There was, especially, a lot of pitch variation, most of it easily traceable to the tape recorders, both recording and playback. There was electronic distortion all along the way, of course, and most objectionably in the still-new tape recording method—varying from practically none, at best, to a great deal, at worst. But none of these factors, as I see it, was as concrete and specific in the 1952 sound as the "sound" of the actual cutting heads themselves.

Remember that until 1948 a 78-rpm shellac disc was perfectly OK for public acceptance with no more than, perhaps, 6000 cps at the top and a great deal of assorted all-over distortion, mostly masked in the high-end, plus a large amount of severe loud-passage unpleasantness, more or less taken for granted what with the hopelessly inadequate inner 78 grooves and the uncompliant, grossly crude tracking of the average home reproducing pickup. It wasn't until LP that these things began to be unpleasantly noticeable on much home equipment. It took a huge effort to remove them—after LP was launched, for the most part. The cutter was the key.

So, in many 1952 records you will find a continuous distortion (as per above, the beginning of this piece) that I feel strongly inclined to pin upon the disc cutter head, even if it did add its own to distortions already present in earlier stages.

You will also notice an even more tell-tale cutter distortion, which I know from my memory that we accepted then as a matter of course—the extra-distortion of louder passages. We still have the problem faintly today. But in 1952 you will find a great number of discs which purr like so many hi-fi kittens in the softer passages, and as soon as volume goes upwards break into a most unpleasant shrillness and, as I used to put it, "buzziness." Cutting-head trouble, I'll wager.

The trouble was, then, that our home pickups reflected precisely similar characteristics! They were tough, reliable, relatively wide-range in their response and relatively flat, too, given a nice quiet passage. But in louder passages they buzzed all over the place to beat the band. They did it quite impartially, of course. As we heard the 1952 discs, a clean loud passage buzzed just as merrily as one that in fact was "dirty" on the record itself.

So—I'm giving a tall guess that a major factor in the introduction of each of the new "initial" record labels around 1952 was the introduction, behind the scenes, of new cutting head equipment and associated circuitry. You can spot it, I maintain, by the very sound of those new records. They were suddenly cleaner, smoother, wider in tonal range; but they were *particularly* cleaner in the loud passages.

. . . And Tape

Yes, there were tape problems, of course. Especially among smaller outfits and very especially among those who had to work in Europe, with the everlastingly unstable European voltages! But even American tape suffered, as I immediately recognized when I surveyed my batch of 1952 discs.

You can't pin down the precise all-electronic distortions that come from a master (or copy) tape as distinguished from those originating elsewhere. Not most, anyhow. But a few typical tape distortions do show up immediately and amusingly—as of 1962. Pitch distortion was the biggest one of all. It's astonishing how much variation in basic pitch was tolerated by us listeners, from movement to movement. Try the beginning of a record, then, maybe, the opening of the second movement. A quarter-tone flat, or even more! Tape trouble. Some of it was laboriously corrected by variable-speed tape playback. But a lot wasn't, even on reputable labels.

Much worse, of course, were the momentary pitch inaccuracies. They vary from those brief sags, five or ten seconds long, which now startle me into thinking my turntable must be out of order, through the dreadful cases of incipient wow that,

in particular, took the musical salt out of so many piano recordings, and on to the sort of flutter that put an ugly *brrrrr* into all sorts of musically-intended sounds that should have been rock-smooth, and are in today's recording. Tape was bad, variably, and good variably, like everything else in 1952. The best in tape went straight into the new high-standard discs with the fancy initials on them.

Try These . . .

P. S. Want to delve into 1952 for yourself? I won't try to be exact, but you'll get an idea of what I've been talking about if you explore the record library in the region of the following numbers. Variable time-lags in production are inevitable; but these are the types of records you would have been hearing in May 1952 if you had recently been in the market and were trying to keep up to date:

Try domestic Columbias in the ML 4400's. RCA LP's (you can forget the 45) in the late 1100's, the early 1700's. (The numbers apparently jumped over intervening categories. RCA numbers aren't trustworthy as to dates.) Listen to Westminsters in the low 5100's, Capitol after P-8154, the early FDS. Mercury in the 50000 series, beginning the Olympian "Living Presence." Vanguard in the very low 400's—they were just beginning. Vox from around LP 7100 through roughly the 7700's, edging into 1953. Uranias—if you have any—in the 5000 and 7000 series. Allegros in the 3000's and from the 70's to the early 100's.

London *ffrr* is plain nuts—I never could figure their number system. But some Londons in the 400–500 series belong in this period; also the low numbers, 28, 40, and so forth. All these since withdrawn and some re-cut later according to RIAA, as with the Westminster 5000's and many others.

There weren't any Angels, of course. The Angel parent company in England, the lordly EMI, if I remember correctly, was still busy making 78's in 1952, and not a word about LP. The late Mr. Barrell, EMI big-shot, used to visit over here every year and we invariably quizzed him on the subject of EMI LP's—to come. Not a word out of him. Not, even when one year, maybe about that time, he arrived like a cat with a mouse, a batch of anonymous, white-label test LP's under his arm. We asked him whether this meant EMI was at last going into LP. No. comment. **Æ**

THE FUTURE OF AUDIO

(*from page 69*)

and judicious use of the delayed reverberation in the home. Proper dispersion of sound is also important here. In general, techniques to accomplish the desired effect are fairly well known, but a great deal of work remains to be done.

Peter C. Goldmark

• The big improvements which may come will most likely be in the program sources and in the transducers. At present, records, home tape playbacks, and FM radio transmissions are inadequate, not because of limited technology, but because of failure to process for the high quality market.
• Transducers such as phono pickups and speakers will be improved to the point where they match the capabilities of the electronic parts of the audio chain.
• The advent of transistors and newer tube types will not make for better sound, but merely for more economical and more portable equipment.
• I will make one drastic prediction for audio for the next fifteen years. In this period, audio will merge with video; and home reproduction will encompass both audio and video stimuli. This will not cause the end of the audio engineer but will merely extend the audio spectrum into the megacycle range.

David Hafler

• One may be allowed to *guess* that there will always be a 3-way competition between the "package" radio-phonograph, the compact "component" audio, and the truly high quality audio which components can offer. As Howard Souther put it, the quality audio components started with pioneers putting professional quality speakers of large size and stark weird-looking horns in living rooms; "never allow form and appearance to interfere with performance and function."
• My opinion is that there will be a growth of demand for quality systems which means those which are functionally correct where decor and size are made to conform to function.
• No doubt improvements will be made within the limits of the laws of physics, but if I may be permitted to sound a warning, beware the "major breakthrough" which violates the principles of acoustical physics.

Paul W. Klipsch

• The French have a saying that the more things change, the more they remain the same. In the last fifteen years the audio field has done nothing radically new—but has done the same thing radically better. There has been immense attention paid to reducing distortion and non-uniformity of response—so the home audio of today is much easier to listen to. Listener fatigue, in short, has been greatly diminished. I look for this process to continue for another fifteen years, while the bizarre (already discredited) is quietly buried.

C. J. LeBel

• For the future I do not expect to see the same order of improvement as has been made in the past. The improvements will be more subtle. Fine quality reproduction will become more widespread as more and more people hear, appreciate, and want the more realistic sound. To me the instant appeal of fine quality is the real thing which, if promoted, will expand the field almost without limit especially since the penetration of quality systems while substantial is still an extremely small segment of the potential. People themselves are more critical of sound, they are becoming better informed on good sound and therefore more discriminating—demanding the better performing equipment. It is rare that a person who hears a really fine performing system will ever forget the experience nor will he be happy with a system which is much below what he has heard if he can possibly do anything about it.
• The future will mean better value for the quality-conscious public: more convenient and accessible functions, transistors, multiple functions and homes already equipped upon occupancy. The hi-fi field, now providing excellent reproducing capability, will demand better performance from sound sources.

Frank McIntosh

• The field of analysis and synthesis of speech and music will have a very important bearing on high-fidelity sound reproduction in the future. The production of electronic music is now well on the way. By means of a coded record and a synthesizer, a one-half-hour program can be recorded on one side of a disc the size of a silver dollar. Such coded reproducers will provide multi-channel stereophonic sound which will indeed bring the concert hall into the living room. With the speed at which electronic systems are now being simplified and reduced in size in the form of micromodules, the coded record and synthesizer are certainly on the horizon for the reproduction of recorded music.
• The loudspeaker is one element in sound reproducing systems that is long overdue for radical improvements above and beyond its present means of converting electrical into mechanical energy. Such new conversion systems will probably be of the solid-state type, either passive or active. Any nonlinearity in the transduction will be reduced to an imperceptible amount by means of fine controls for synchronizing the sound output with the electrical input. These reproducers can be in the form of thin segmented sheets which hang on the wall. Each element of the sheet will be driven separately from the synthesizer to provide concert hall auditory perspective. These reproducers will make it possible to build a radio receiver or phonograph the size of a cigarette package with performance surpassing that of the finest large-scale component systems in use today.
• Studies now being made in the storage of information will also be applied to sound reproduction. Records will be developed that store more information, by orders of magnitude, than existing records. Combined with synthesis, a thousand hours of reproducible music will be stored in a space now occupied by one or two present-day, long-playing records.
• Electronic machines are indispensible to the sciences as aids in solving problems. There is every reason to believe they will be of similar assistance in the arts. Their use in the production and composition of music is now in an early stage of development. Eventually, they will provide aid in search, learning, planning and induction in the composition of music. However, just as they cannot in other fields, machines will not displace the creative capacity of man in the production and composition of music. They will only free man of the drudgery in this work and thereby allow him more time for creative effort.
• To achieve maximum benefit from this new development—this new and close relationship of science with the arts—the scientist and the artist must join forces more completely and seek to understand more clearly the terminology and problems of each in order to advance the disciplines of both.
• The fact remains that the human voice and ear still constitute the most important system for the transmission and reception of information. As in the past, the mission of the audio scientist and engineer is to further implement and to further elaborate this system. I believe this will be done and that the tremendous advances already made through electronics in support of this basic human system are only a prelude to the truly amazing achievements yet to come.

Harry F. Olson

• In my opinion, our magnetic recorders will use some sort of cartridge or magazine and the tape will not be handled directly.
• Magnetic recording equipment will be developed similar to a Juke Box. This equipment will contain an extended amount of selections; any selection could be played back by turning a few knobs or the machine will play all selections in some sequence.
• There will be very efficient recorder-playback units in cars. Driver could dictate or listen to music or lectures of his own choice.
• There will be pocket units developed of extremely small size and of high fidelity calibre. The person attending concerts or meetings could record anything he would like to have recorded.
• It is obvious that the use of audio recording will expand tremendously in all language schools.

Alexander M. Poniatoff

• Having lived right in the midst of high fidelity's many remarkable developments in the past 15 years—I find it particularly pleasant to sit back and "imagineer". . . on things to come 15 years hence.
• For one thing, I believe automation will play a significant part in high fidelity. All types of sensors and other magnetic devices will be used to make the home music system fairly self-sufficient . . . leaving the music lover the sole task of finding a comfortable chair to sit back in . . . and listen!
• Components will shrink in size . . . wireless audio controls will fit into the base of a lamp, a bookend or the palm of one's hand and will include provision for controlling the radio tuner. It will actually transmit supersonic signals to a sensor receiving unit. Power amplifiers and radio tuner chassis will be located in space normally wasted . . . there will be virtually no heat because transistors and rechargeable batterypacks will permit cool low-voltage operation . . . hum will no longer be a problem. Moreover, the batterypacks will automatically recharge themselves at a predetermined voltage level. Phonograph turntables will be reduced to a few inches in diameter . . . their motor will be replaced by a wafer-thin magnetic circuit rotating at the precise speed of 2 rpm. Multiplex stereo grooves in a 4-in. record will provide hours of music containing as many as 24 selections on a single side . . . each would be selected by switching to a different frequency unscrambler by means of magnetic sensors.
• Phonograph cartridges will achieve a degree of sensitivity so great, they will respond to microwave vibrations riding through a record groove as if in orbit. They will contain micro-miniature high-frequency transmitters obviating the need for interconnecting cables. As a matter of fact, a complete record playing system will be so compact, it could be moved and operated remotely from any part of the house without a plug or wire in sight. Tape recorders will be made more compact—about the size of a package of pre-recorded tape as we know it today. And, it will run at one speed for hours, with the best fidelity. A built-in super-sensitive microphone would record a second program simultaneously . . . using a multiplex channel so the existing recording would not be erased.
• Speakers will be installed all through the house. They will be electrostatic—requiring little more space than that occupied by a wall receptacle today. Private listening will be quite popular, using tiny ear receivers that require no wires and volume level would be automatically controlled by the noise level in the room.
• The quality of high-fidelity music reproduction will improve immeasurably . . . problems we have today with noise and distortion—insignificant as they may be—will not exist 15 years from now. New circuitry and electronic developments will operate in a new dimension free of dependency upon local utilities. One thing is sure . . . high fidelity will be stereo . . . but I won't venture any guess as to the number of channels we will have.

Walter O. Stanton

• I would feel a lot safer talking about 25 year from now instead of 15. Anyway, I think that sound reproducing systems will be smaller, easier to install, simpler to operate, less expensive in spite of historical inflation, and higher in quality in the sense that the sound will be closer to the live instruments.
• My guess is that speakers will be spherical in shape, small, without enclosures.
• I think that an increasing part of the energy put into high-fidelity components today will be used to improve hearing aids.

Ed Villchur

• The signal-to-noise ratio of tape recorders will be so greatly improved during the next 15 years that the tape machine, when used in connection with cartridge tapes, will become the commercial rival of discs.
• I predict a 20-db improvement in the signal-to-noise ratio, which will make available machines with an 80-db ratio.
• This achievement will eliminate all equipment noise; making blank tapes noiseless when played on the proper equipment. Now what do you think? Æ

W. W. Wetzel

JAZZ and all that

CHARLES A. ROBERTSON

STEREO

Terry Gibbs: The Exciting Terry Gibbs Big Band
Verve VSTC 264 (4-track UST stereo tape)

Fifteen years ago big bands were coasting along on momentum gained during the swing era, but most leaders thought postwar prosperity would create a great new demand for their services. So many explanations are given as to why this failed to happen that the only mystery still remaining is the continued existence of any big bands at all. Both Count Basie and Duke Ellington could maintain small groups and do as well or better financially, while Harry James and Maynard Ferguson would climb to much higher tax brackets at the head of popular dance orchestras. Even more remarkable is the changed attitude of established studio musicians, many of whom are less resistant to going on the road than was the case a few years ago. Others take care of that restless urge by devoting time and effort to rehearsal bands. It looks as though musicians have yet to find a satisfactory substitute for belonging to a swinging band, and the periodic need to relive the experience is likely to keep bands from dying out for some time to come.

Terry Gibbs is a good example of the jazz star who feels the pull of heading a band again more strongly than the comforts of a safe existence. Work in Hollywood studios, recording and television keep the vibraphonist busy. If he wanted to tour the jazz clubs, he would have no trouble finding engagements for a quartet. Instead, Gibbs organized a rehearsal band two years ago, launched it on weekend dates around Los Angeles, and finally brought it into The Summit for this location recording. So far, the persons profiting most from the venture are record purchasers, and any big band fans who invest in the stereo tape just released will also get a good return for their money. Gibbs remains undaunted, however, and Mercury is giving the band another boost by recording it at the Hollywood Club again on April 3rd.

Gibbs ended the first phase of his career as a youthful prodigy in a Major Bowes unit, but the second phase was well underway fifteen years ago when he worked with Buddy Rich. He was a member of Woody Herman's "Four Brothers" band for a year, then formed a band of his own just as the going got rough. Most of the past decade was spent leading small groups and in studio work. His present ideas of how a band should sound reflect Herman's zestier side, and he plays vibes with all of Lionel Hampton's exuberance. Tunes are stomped off vigorously, and encouraging shouts drive the soloists on.

To bring the band's style thoroughly up-to-date before recording, arranging commissions went to Bill Holman, Al Cohn, Manny Albam and Shorty Rogers for the freshest sounds around. A bill of more than $2800 for these services on the debut album, exclusive of copyist fees, may well cause other aspiring leaders to ponder taking a similar step for a while. The advanced thinking of Charlie Mingus is harnessed on Holman's *Limerick Waltz*, with Joe Maini's impassioned alto sax pointing the way over the skilled rhythmic pulse of drummer Mel Lewis. Rogers makes note of the current gospel trend on *Summit Blues*, as Buddy Clark's fine walking bass outlines the text of today's sermon. Further proof of the appeal of swinging in a band is the presence of Pat Moran, a young lady pianist who usually records with her own trio. Albam assigns her a Basie role to introduce Ellington's *Main Stem*, and follows up with a stirring serenade to *Sweet Georgia Brown*. Cohn sums up the entire affair on *Nose Cone*, a jet-propelled vehicle for the leader's rocketing vibes.

The Summit is becoming a popular West Coast spot for band recording because of several advantages not always found in studios. Apart from the benefits of audience enthusiasm and good acoustics, the room allows leaders of touring bands a chance to hire extra soloists and break in new arrangements before recording. In addition to the two Gibbs dates, Bill Putnam's United Recording Corp. also handled an augmented band Louis Bellson brought into the club to record a program of Benny Carter arrangements for Roulette. Wally Heider, who engineers many of United's location jobs, points out a personal reason for liking the room.

"When big bands are recorded in the studio," states Heider, "most producers insist on split stereo, with brass on one channel, saxes on the other, and the rhythm section divided up or fed equally to both channels. My own preference is a wall of sound for stereo, and I can usually convince everyone concerned that this method gives the most natural sound and safest results in a club. Actually, it requires closer attention to mike placement and a keener ear at the controls. I used this 'head-on' approach in the studio when recording the Roulette album of Count Basie's band playing "Kansas City Suite." With bands like those of Basie and Gibbs, the expert dynamic shading of the call-and-response patterns between sections makes it impossible to go wrong."

A jazz fan of long standing, Heider also became interested in audio as a hobby while practicing law in Seattle. Before combining the two avocations in a professional career, he held his own rehearsals by recording informal practice sessions of local units and anything else that came along. When Putnam sold Universal Recording and moved from Chicago to open United three years ago, Heider was ready and willing to leave the law in other hands. He credits Putnam for putting the finishing touches on his engineering education, and a good share of the jazz assignments come his way because he knows the subject. Among his forthcoming efforts are one-hour programs featuring Les Baxter and Stan Kenton for a new syndicated radio show, and an Art Blake remote at a Los Angeles club. One flaw mars this gilded existence, according to Heider, in that many master tapes go to distant points for final mastering. He always equalizes tapes with reference to his knowledge of the band's live sound and sends out the end product ready to be mastered flat. Pressings often come back with added echo or altered highs, but four-track stereo tapes are always prepared direct from the master tape. Happily, both mono and stereo versions of the first Gibbs date are mastered flat, although the jukebox trade receives an echoed single of *Limerick Waltz*.

Frank Sinatra picked Heider to pack remote equipment and go along to record an around-the-world concert tour this spring, starting in Tokyo late in April. But prior to that six-week experience, Heider was back at The Summit helping Terry Gibbs to revitalize the glorious sounds of fifteen years ago one more time.

Dinah Shore: Dinah, Down Home!
Capitol Stereo ST1655

Ann-Margaret: On The Way Up
RCA Victor Stereo LSP2453

The pop market still favors male vocalists, and determined promotion can still strike it rich for the youth who has no more to offer than slight ability and an obnoxious personality. Girl singers never had it this good, as no amount of paid publicity is much help to aspirants lacking in feminine charm, talent and the will to work hard. Even these attributes seldom guarantee entry into the higher brackets, unless the singer also is versatile enough to make every opportunity pay off. Dinah Shore has yet to miss a trick, but she was just another promising young hopeful on arrival in New York from Memphis a good fifteen years ago. Her big chance at network radio came with weekly appearances on "Chamber Music Society of Lower Basin Street," a sustainer of mild dixieland thrown together to keep staff musicians busy. Besides enlivening the show, the new vocalist earned the respect of Local 802 members, gained a host of admirers and drew the executive attention which sent her to Hollywood.

With Jack Marshall acting as escort, Miss Shore returns to the scene of her early triumphs and once again sounds as unsophisticated as a schoolgirl out on her first date. Tucked away among the usual favorites are revisits to the fire and brimstone of Willard Robison's *The Devil Is Afraid Of Music*, and the friendly warning of Harold Arlen and Johnny Mercer that *Any Place I Hang My Hat Is Home*. Marshall heads a good group, and his settings vary from a dreamy *Moon Country*, all the way to the rollicking banjo beat of *Roll On, Mississippi*.

Ann-Margaret started out as a protege of George Burns on the comedian's television show and made a conventional debut album under Marty Paich's direction. Currently appearing at movie theaters in a new version of "State Fair," she first went to Chet Atkins to learn about the latest fashions in country style at the source. Although part of her second album was recorded in Hollywood, the typical Nashville sound is present throughout, from soporific choral group to back-beat drummer. The twenty-year-old import from Sweden fits into this down home environment like one of Elvis Presley's cousins, even to the extent of a gospel-charged *What Do You Want From Me?* A lonesome harmonicist takes off his shoes on *I Just Don't Understand*, and it would help matters if his doleful moan had chased away the assisting vocalists on *Moon River*, *Heartbreak Hotel*, and *Let Me Go, Lover!* Ann-Margaret may have impressed adults before, but now she has teenagers and the country folk right in the palm of her hand.

Art Blakey: Mosaic
Blue Note ST84090

This album title may alarm some loyal Art Blakey fans, as they know from experience what happens when the group starts playing in neat, preset patterns. Personnel changes invariably result, either because the drummer urges some fledgling to take off on his own, or tempting offers come from other leaders. Blakey always seems to welcome the chance to watch over a new edition of the Jazz Messengers, and the one formed last summer can already point to a successful tour of Japan, climaxed by an hour television show in color. The new members are meshing together more quickly than is usually the case, mainly because pianist Cedar Walton and trumpeter Freddie Hubbard formerly worked with J. J. Johnson. Swelling the ranks to sextet size is Curtis Fuller, a trombonist whose style resembles Johnson's enough to make the recruits feel at home. Both Blakey and Wayne Shorter, on tenor sax, are far from being restful companions though, and the drummer's fiery pace keeps everyone on the alert.

Walton is credited with the overall design of *Mosaic*, but the individual pieces are shaped to fit on the spot in something less cold and stiff than stone. With Jymie Merritt assisting on bass, the rhythm section varies its attack and achieves the effect of kaleidoscopic motion in fully-rounded stereo. Shorter, Hubbard and Fuller also contribute originals bearing Blakey's stamp of approval.

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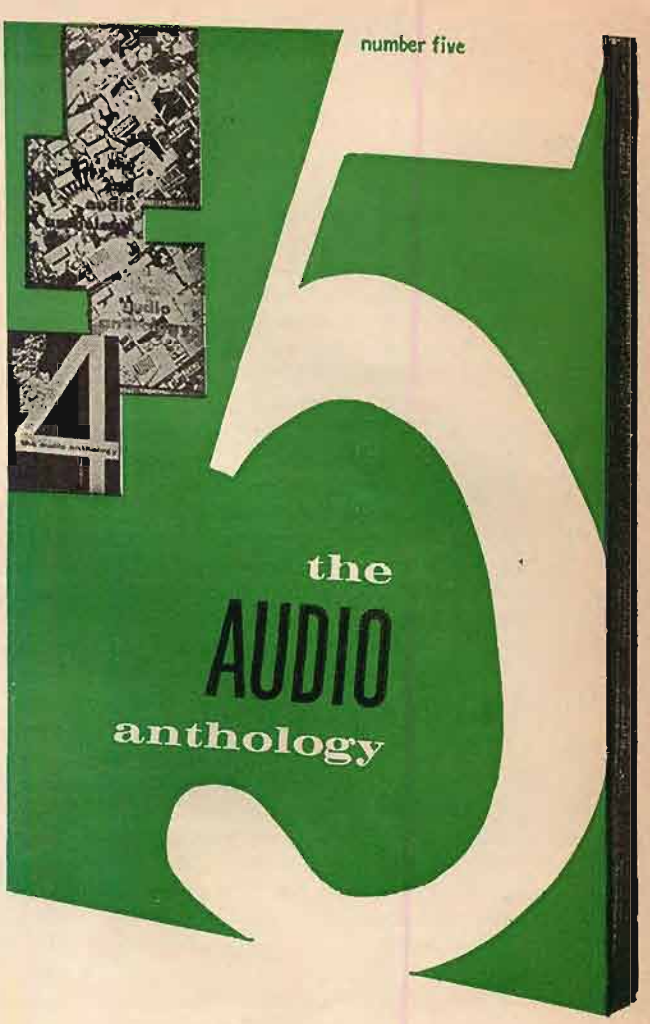

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TRANSISTORS

(*from page 24*)

derived from loads in the collector circuit of the p-n-p driver transistors. Emitter degeneration is employed to insure a high degree of linearity in the operation of the output circuit.

A single-ended signal representative of the double-ended output waveform across the load is obtained from a novel one-transistor difference amplifier. Appropriately attenuated signals from each side of the load are used to drive the base and emitter of the difference amplifier. The use of a large resistor in the emitter of the difference amplifier insures a very high degree of difference amplifier balance and stability regardless of possible changes in transistor characteristics. The single-ended and amplified output appears across the difference amplifier emitter resistors. It is injected in a conventional manner to an earlier low-level stage in the amplifier, thus completing the feedback loop. The elimination of output and interstage transformers allows a large amount of stable feedback which produces a linear damped output without ringing, and greatly extends the low-frequency capabilities of the unit. The use of diffused-base power transistors with common emitter cutoff frequencies greater than one megacycle assures adequate high-frequency response.

This description does not bring out one important feature of the full bridge which helps to make the full bridge a very attractive circuit. So long as power transistors 1 and 3 are driven hard enough the system can be completely controlled by transistors 2 and 4. The split off to the n-p-n driver is not too critical, therefore, and the close balancing is only needed in the p-n-p side.

The only European amplifier so far located is that designed for use with the French Orthophase loudspeaker: this is a giant assembly of large and robust ribbon microphones. To drive this speaker to 100 w, an amplifier using a half-bridge with two parallel transistors in each arm has been designed (see *Fig.* 8). The driver is transformer coupled to the output stage, which has + 24- and – 24-v. supplies. The transistors used are the OC36 low-frequency transistors, though the ASZ18 is being adopted. The OC36 has a common-emitter cutoff frequency down around 3500 cps and something of the order of 40 db of negative feedback is taken round from the live end of the speaker to the base of the high-frequency power transistor driver. The driver itself is fed through a transformer from the preamplifier. Negative feedback is also used with two anti-resonant circuits to deal with speaker peaks on 300 and 3100 cps. Although this amplifier will give 100 w at 50–2000 cps, the available power drops away to 25 w at 10,000 cps and 10 w at 20,000 cps (though the ASZ18 gives better results). The response is flat to ±0.1 db from 50–20,000 cps and up to 2000 cps the distortion could not be measured. The really interesting feature here is the use of low-frequency transistors and good orthodox design to allow plenty of feedback to be used: the pay-off, the very low cost of the transistors.

Can we see any common style developing yet? I think not. Certainly the output transformer is out and my guess is that the half-bridge circuits will win in the end: but what does my guess really mean? Only that I would start off by using half-bridge circuits myself. But there is something more needed somewhere before we really hit the answer on output stages. Let us go back to the other end of the amplifier.

Front end design is, in some ways, more uniform. The phonograph input is designed to accept some 3-5 millivolts and a two-stage preamplifier is used to raise the level to the level at the next selection point. Equalization for the RIAA characteristic is provided by an RC feedback network connected between the second collector and the first emitter. This low-level input may also be used for tape, in which case the equalizer network is switched by the input selection switch. Some, but not all, amplifiers allow an in-

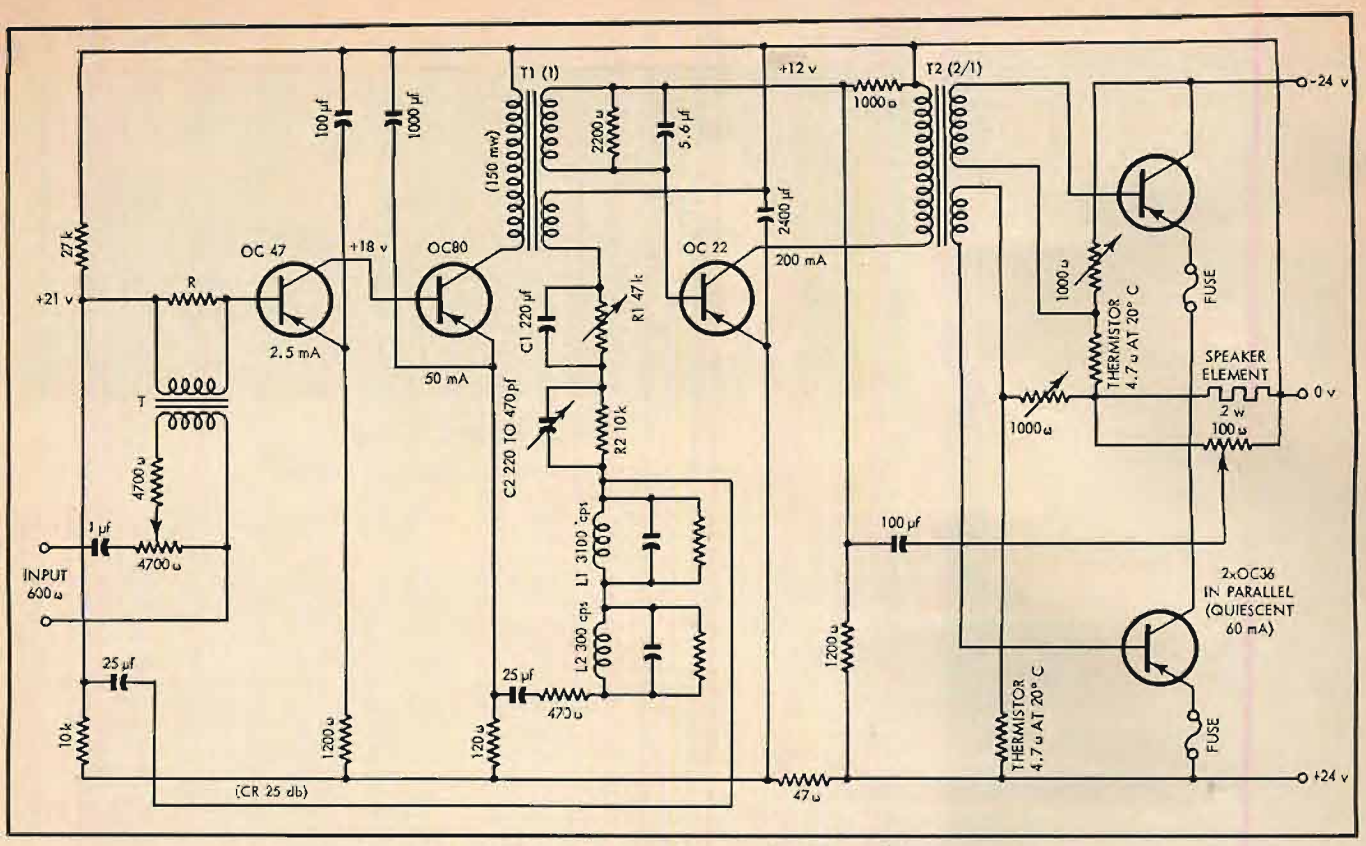


Fig. 8. Circuit of Orthophase OR6T120 Amplifier.

put to be connected after the preamplifier. Tone control follows the preamplifier and appears to be standardized as a single-stage transistor amplifier with the response control in the feedback path. Volume and balancing may be before or after this stage. From this point on we are in the main amplifier.

(*Continued on page 85*)

ABOUT MUSIC

Harold Lawrence

15 Years Later

1947. A year before the coming of the long-playing record. "High fidelity" was not yet a layman's concept. It was the record business, not the "recording industry." Heavy pickups, cactus styli, and plain record sleeves were still in use. Bizazzes and kadoties roamed through the hushed confines of the late Gramophone Shop in New York. To most of us, discounting was something that went on in the "wholesale" district. A trio of giants dominated the record scene: R.C.A. Victor, Columbia, and Decca; while the "odd labels" restricted their activities to jazz, folk music, and esoterica.

The postwar boom in record sales had reached a high point. Record dealers stocked bestselling albums as if they would never be able to order them again. Hard put to supply the demand, manufacturers were forced to reduce everyone's orders so as to spread their product over a larger number of outlets. Certain leading shops, therefore, deliberately over-ordered such albums as the Tchaikovsky *First Concerto* (Horowitz/Toscanini), and also the Grieg *Piano Concerto* (Rubinstein/Ormandy), by the hundreds so as to be sure of obtaining quantities close to their real demand. (As the supply caught up with the demand, this little trick occasionally backfired.)

Less Per Minute

Today the consumer pays less per minute of music than he did 15 years ago, records being one of the rare commodities which did not spiral upwards in price during these inflationary years. A recording of Tchaikovsky's *Pathétique Symphony,* for example, cost some seven dollars on 78's; today's LP versions are priced anywhere from two to five dollars less (in monophonic form).

The lowest-priced imported record, however, was higher than the prime 12-inch domestic disc: Americans paid $1.50 for the 10-inch, plum label H.M.V. record which contained some five minutes of program material. The larger discs sold for $2.50 apiece; and certain choice items such as James Joyce's reading his *Anna Livia Plurabelle* went for $12.50.

It should be stated at once that the avid record collector was not daunted by these prices. Just as many big-city dwellers now spend more on rent than they should, the middle-income connoisseur of 1947 behaved like a Florentine nobleman of the Renaissance when it came to acquiring the imports dear to his heart. And dear they were —Debussy's *Pelléas et Mélisande,* for instance, extended to no fewer than twenty top-priced French H.M.V. discs, whose total cost was $50. Arias by Ferruccio Tagliavini were being snapped up at $4.25 per disc, which came to more than fifty cents per minute of music (as opposed to ten cents per minute on the average operatic LP).

Popular Imports

The popularity of imported discs among a small but devoted segment of the record-buying public led to some extreme practices. With their abundant supply of shellac from India, British manufacturers were able to produce discs with exceptionally quiet surfaces. This, combined with their high standards of craftsmanship, made many of our U.S.-made records sound as if they had been pressed on sandpaper. As a result, quality-conscious collectors sometimes would place special orders with their imported-record dealers for English pressings of *domestic* recordings—at two and a half times the price. Even the most silken H.M.V. pressing, however, could not eliminate shellac hiss entirely.

Around this time, R.C.A. Victor and Columbia brought forth some of their new releases on Vinylite pressings, the former in rich, ruby translucency, and the latter in a more conservative black. The public was less than entranced. Many of the "silent" surfaces were hardly quiet at all (the bugs have still not been eradicated in today's LP Vinylite grooves), and, to the owner of a low-fidelity table radio-phonograph, the advantage of the new discs over the shellacs was not abundantly clear. Besides, they were more expensive.

Apart from their technical superiority in terms of the actual disc, the British were making enormous strides in sound reproduction. In 1946 the first "packaged" English Decca *ffrr* albums made their appearance in the U.S. Never before had such extraordinarily realistic orchestral sounds been engraved on a disc. More than any other event, the release of this album brought "high fidelity" to the American public during the 78 era.

It Was Easier Then

The record reviewer's lot in 1947 was a lot happier than it is today. A full-time critic could then cover a major portion of the recording output, including imports. Today he is lucky if he can keep up with his special field or repertoire. Playback systems, too, were less of a problem simply because there were very few component manufacturers on the scene.

Record producers (artist and repertoire directors) also had a much easier time of it. Since everything had to be recorded in segments of from two to four-and-a-half minutes, a record side was cut over and over again until everyone was satisfied. A controversial element has since been injected into the record-making procedure: the tape editor. Seldom does a performance now move from the recording hall to the tape-to-disc transfer room without the cosmetic nicks of the editor's blade.

The picture on the album cover was still a relatively new development. Compared to many of today's LP jackets, the 78 cover was as tame as the art work for a book of

fairy tales. There was Brahms at twilight strolling through a Disneyite forest, Mozart in cameo-souvenir likeness gazing serenely into space, and the picture of the cut diamond to tell us that Beethoven's Violin Concerto is a gem of a work. Few of the illustrated covers were to match the elegance and good taste of R.C.A. Victor's embossed, gold-lettered albums with buckram spines, which were introduced just before the lifting of the Petrillo ban in 1944.

Discounts

In 1947 the idea of buying records at a discount was almost as outlandish as asking the newsstand vendor for a reduction in the price of your daily paper. The time was soon to come when discount merchandising and "perpetual" sales were to become the order of the day in most cities.

One could still be sufficiently *au courant* in 1947 to have sampled or heard in its entirety each important new release. In minutes of music, the record companies still produced only a tiny fraction of what they (and all the LP-spawned firms) bring forth today. New recordings were awaited eagerly, and, for weeks and even months following the releases, homes and record shops would reverberate with discussions on the merits and weaknesses of the latest crop of Columbias, R.C.A.'s, or imports. In today's crowded market, too many releases pass virtually unnoticed, lost in the unremitting torrent of new material pouring from dozens of sources.

Audio shows were years away in 1947. The average classical record buyer was still blissfully unaware of equalization, cartridge design, crossover networks, and tonearm resonance. He just put a record on his turntable, ran his finger across the "needle" point to see if the rig was on, lowered the arm (or set the changer mechanism), and relaxed. Occasionally he might adjust the treble or bass controls, but, compared to his later-day counterpart, he was nothing less than a sonic primitive. But that was before AUDIO came along. Æ

TRANSISTORS

(*from page 83*)

One feature which the *Fig.* 7 circuit includes, which is not in the others, is a smoothing and regulating transistor in the power supply. This is a series transistor with its base fixed by a zener diode and the rather rough d.c. applied to the collector. At the emitter the voltage should be smooth and constant, just what is needed for the more sensitive points in the circuit. The French designer uses an inductance for smoothing the supply to the low-level stages but otherwise it's just RC, RC.

This, then, is the round-up to date. British manufacturers say no one wants transistor power amplifiers, that no one is offering them, that Mr. — will call back. Thus will be in the hands of the printers, or the readers, by the time the London Audio Fair comes along. If there is anything you should know about, you will be told. After all, there is a classical tag which you can look up for yourselves in the original—from the East always something new and strange. Æ

LIGHT LISTENING

(*from page 10*)

did during low-level passages in classical music.

I never realized how good the highs on those old two-track stereo reels were until the ultra-narrow-gap heads demanded by four-track tapes made their appearance. In going back over my stack of two-track tapes with a tape head designed for four-track, I was tickled to discover that the superior frequency response of the ultra-narrow gap performed another function. Earlier tapes I had once considered shrill in the range between 7000 and 10,000 cps now sounded much smoother when the new response above 10,000 had a chance to balance out the stuff beneath it. To take one example at random: the first tape I headed for when I got a machine with the new heads was the Columbia Original Cast two-track of "West Side Story" issued in 1958. On the old machine (same make as the new one) I had to roll off highs wherever I could on the preamp but the darn tape still couldn't be made to sound as flat as the mono record version. When I switched tape machines a few years later without disturbing the rest of the system, the "West Side Story" tape came under control without a knob being touched.

In the matter of bass response, two-track stereo tapes are still in a class by themselves. Only these tapes can bring into full play my four wide-excursion woofers. It may be pointless to talk about tape releases no longer in print but the best foundation shakers I have in my collection are two-track stereo tapes such as the "Band of the Coldstream Guards" under the direction of Major Douglas A. Pope (RCA Victor BPS-112) and Dick Schory's New Percussion Ensemble in "Music for Bang, Baaroom and Harp" recorded on the home grounds of the Chicago Symphony Orchestra on RCA Victor tape CPS-203. In the top end, these tapes may fall short, by a thousand cycles or so, of the very best stereo discs we have available today but that bass end is a powerhouse you'll probably never encounter on a disc in the foreseeable future.

The psychological attributes of the human ear being what they are, today's four-track tapes sound adequate when you let some time go by after you've been exposed to a good two-track. In the case of a poor and distorted two-track, you may be able to enjoy a four-track after an hour or so has elapsed.

The history of the stereo disc is still fresh enough in the minds of most sound fans to require little comment today. I did my share of groaning and head shaking when the first stereo discs came out. Within a year, however, I was willing to concede that most of the faults of the early discs were traceable to the first stereo pickups. By the autumn of 1958, the components industry had on the market a stereo pickup that still turns in a creditable performance today in the company of the very latest high-compliance cartridges.

Anyone using such a pickup in a good system during the early days of stereo discs would have noticed, as I did, that the best-sounding releases came from a source in Saukville, Wisconsin that had achieved fame in the mid-Fifties with a micro-groove 78-rpm mono disc. The Audiophile

label, run as a superbly engineered hobby by E. D. Nunn, put out the first stereo discs that combined good separation with a wide frequency range. The first London stereo discs had a healthy frequency response but it was attained at the expense of normal stereo separation.

ONCE the recording industry had a workable two-channel disc, stereo's first mass audience came into being. Significant help in spreading the use of stereo came from such familiar show albums as "My Fair Lady," recorded in London in February of 1959 with essentially the same Broadway cast featured in the earlier best-seller mono version. Solid shows such as "Oklahoma" and "The King and I" had their stereo innings in effective early stereo disc recordings taken from the sound tracks of the movie versions. Listeners unimpressed by a concert hall ambience that may have been unfamiliar to them, responded to stereo's recreation of a performance on a stage or a movie sound lot.

Any survey of the past decade should make at least glancing reference to the 3.75-ips stereo tape cartridge that was championed by RCA Victor some three years ago. I've never been able to muster sufficient enthusiasm for that tape system to discuss it in print or over the air. When I attended the first public showing of the tape cartridge, the same recording was played for the press in two versions . . . tape cartridge at 3.75 and stereo disc. Somewhat to my surprise, I preferred the sound of the disc even though the latter was played on a console phonograph with an early ceramic pickup.

Another recent development in the record industry is the attempt to revive the 45-rpm microgroove disc. The basic advantages of a speed higher than 33⅓ rpm have been known for some time. At 45 rpm, stylus acceleration in the stereo cutter and playback pickup is not quite the problem it is at the slower speed. A stereo pickup on a 45-rpm record has more distance in which to perform a given complicated antic than it does at 33⅓ rpm. The importers of the Schoeps condenser microphone have brought out a line of 12-inch 45-rpm stereo records to the accompaniment of groans of anguish from other labels and manufacturers of single-speed turntables. I secured two test pressings of the new label, called appropriately enough Quarante-Cinq . . . the French word for forty-five. I grant that my reaction to the discs may be influenced by the fact that I have a three-speed table. The sound I get is a distinct departure from the conventional LP. Unlike some subjective reactions in this field, this one is easy to describe. The sound of these 45's has an open quality that the old 7-inch 45-rpm mono discs never exhibited. Quarante-Cinq record #45002 called "Bravo! Toro" features music of the bull ring and contains 16½ minutes of music on one side that is split up into five bands. A companion release (Quarante-Cinq 45001, "Music of Chabrier") delivers 19 minutes of music on one side. This is a clear indication that the variable-groove method was used in making the master. The recording level on "Bravo! Toro" is no higher than that found on well-made current 33⅓-rpm stereo discs. If the masters of these 45's were made with a conventional stereo cutter, it is interesting to speculate on the results that might be attained if the cutters now in use were to be modified for operation at the higher speed. As things stand now, the transients of the castanets are a particularly convincing demonstration of

the forward strides taken in these latest 45's. Whatever new developments come out of the recording industry in the years ahead, I feel reasonably confident that the readers of AUDIO will be as quick to support the genuine as they have been to reject the make-believe. *AE*

THE ART

(from page 6)

gradually built up to somewhere between 20 and 30 db, without too much trouble. Distortion, measured into a resistance (dummy) load, was really low and engineers were happy. Sometime listeners weren't, because they were faced with the necessity of using a loudspeaker load, to provide watts they could listen to. Low distortion in a resistance is one thing; getting the same quality into a loudspeaker voice coil proved to be another.

Multi-loop feedback served two purposes. First, the more-feedback-the-better group could now add the figures in the various loops and get a total close to 100. As the customer had always rated things by per cent, maybe he thought db was a misprint!

The more sensible thing that came out of multi-loop was enabling feedback to achieve each of its advantages—reducing distortion, controlling output impedance (damping), stabilizing gain, and so on—independently and at the same time.

Even today, however, we hear db figures quoted for the "amount" of feedback, which is strictly not a good practice. If the amount of feedback is exactly a certain figure, and fixed at that figure, then it is not reducing distortion, modifying impedance, stabilizing gain, and so forth, because none of these things need doing (wonderful hope!) and therefore feedback isn't needed in the first place. In other words, the very fact that these things do need caring for, and that properly designed feedback does it, means the feedback is *not* constant, and therefore quotation of a simple db figure is meaningless.

Feedback was also applied to "front ends" or preamplifiers. Theory showed feedback reduced noise, hum, microphony, and anything else that might be a problem. Unfortunately such theory was mere algebra and did not include the complex functions, or take into account level changes. When these were taken into account, it was found that feedback does not help low-level input stages as much as expected—in fact, it *could* make matters worse.

Those Low Levels

In the early days, preamps for low-output pickups (or microphones) needed all kinds of massive shielding, tubes

mounted in super-super-antimicrophonic mounts, and d.c. heater supply, highly smoothed, with chokes and capacitors as big as a house, not to mention cost. Those days have gone.

But still we have some trouble with tubes for low levels. We've lost count how many numbers have been issued for improved versions of the 12AX7, only to be withdrawn later. Many preamp makers still find the European ECC83 a better equivalent.

In the front-end, or preamp department, the matter of "how many knobs?" has absorbed a lot of mental energy—and resulted in some unique approaches. A question still asked is, "Why be so particular about having the correct equalization, if you're going to put in all kinds of tone control, so that by the time you're through you don't know what you've got anyway?". We've been thinking of printing a form letter to answer that one.

Boost and Cut

More seriously, there is the question whether separate bass and treble controls are an advantage to the average user. On this score, there are still people who tell us, quite seriously, that nobody can tell the difference (a) between bass cut and treble boost and (b) between bass boost and treble cut. If that were true, it's quite obvious only one control is needed—the volume control! As most of us *can* distinguish bass from treble, or low from high frequency, these controls most definitely do serve functions that any decent ear can distinguish.

However, there is something to be said for a single control that does both at the same time: from bass boost *and* treble cut, through something nearly level, to bass cut *and* treble boost. Such a control would be much easier for the novice to set to the satisfaction of an experienced listener.

For the real tone-control fiddler, most of the time there have been available some super-duper tone controls, that adjust the response at any number of points. At first sight this seems a wonderful idea. It's only in practice that the limitations show. For each filter to produce really noticeable effect, the cutoff rates need to be sharp, resulting in poor transient handling, even in the "flat" position—don't argue, please, it's a fact. If simple, low-rate cutoffs are used, it takes extremely careful listening to find out whether each knob really does something different from its neighbors on either side—so why have so many?

The Latest Greatest

The latest thing in audio is FM-stereo. This writer's view has always been that radio, including FM, is radio, and hence out of audio's bailiwick. Several audio

engineers, including the writer, first took the view that multiplex was also out of their bailiwick. But some of the efforts made by radio engineers finally convinced us that multiplex —the stereo version, at least—most definitely *is* audio.

To the radio man, distortion only means the creation of spurious frequencies that will get him in trouble with the FCC. What happens after it gets resolved into audio doesn't bother him too much, so long as he can (under)stand it. It can have IM and all kinds of distortion, but as long as he can recognize the original, and the spurious frequencies don't cause interference on another channel, he's doing fine.

Actually, the frequencies used for FM-stereo multiplex are much nearer the audioman's bailiwick than the radioman's. And what definitely puts it in audio is the fact that it is wide-range. A radioman's wide-band filter is 100,000 cps wide at a frequency of 100 Mc. In audio, a filter of 1 cps wide at 1000 cps (which is the same proportion) would be considered narrow. A band-pass filter passing from 23,000 to 53,000 cps is just too wide for a radioman to comprehend at all.

So audio engineers have had to learn some new tricks for multiplex. And they've proved equal to it, once the correct bailiwick was established. At first most of them tried to stay with matrixing, because that was something they already knew about. But gradually they found that newer concepts, such as switching, time-division, and envelope detection offered better prospects. Now quality adapters are coming forward in droves.

Testing: 1, 2, 2½, 2¾ . . .

Over the years, methods of test have had their crazes. First form of distortion to get attention, after we learned to measure frequency response with some accuracy, was harmonic. Then someone pointed out that harmonics of individual tones aren't too important—so long as they're there—and that what does matter is how distortion causes spurious effects between two or more tones—intermode.

This really started something. Some contended the two were interrelated anyway, so you could just multiply by a factor to get one from the other. Others discovered that interrelations did not follow predicted patterns. And still others, much later, discovered that you could finagle a low IM distortion figure—according to which form of test you prefer or specify—that did not really signify audible performance with any accuracy (that's being kind about it!).

Square waves had their day. True a square wave can tell you much more at one look than any other *single* test (which eliminates a frequency run, because this involves measurement at many frequencies). But there are many things it can't tell you at all, and it isn't even a true test for transient performance. A good square wave can be finagled, without the amplifier yielding the good transient performance the picture implies.

Tone-burst testing is a little more elaborate, and therefor not amenable to results in simple number form. To be informative, it has to be conducted over the whole frequency range, and its results integrated—whatever that means!

By and large, audio people (the progressive ones, that is) are still looking for more effective test methods, that will measure definitively some of the effects that have been described, demonstrated, and suffered all these years. Anyone who has studied audio knows that no single figure will ever tell the whole story of how a system will sound: sound and hearing are just too complex for that.

As well as getting a more realistic attitude—like mature people—the audio fraternity are now branching out into other fields that are rightly theirs. Audio is much more than high fidelity, and the experience, past, present, *and* future, of the audioman is something that represents a valuable contribution to scientific knowledge. We might say audio is now a solid scientific citizen. Æ

STEREO

(*from page 31*)

familiar with handling discs. As mentioned previously, Wyte, Frayne, and Davis of Westrex, prodded by Capitol Record's Ed Uecke and RCA Victor's Bill Miltenberg, worked on modernizing Blumlein's early vertical-lateral cutter concept. EMI in England also got busy doing the same.

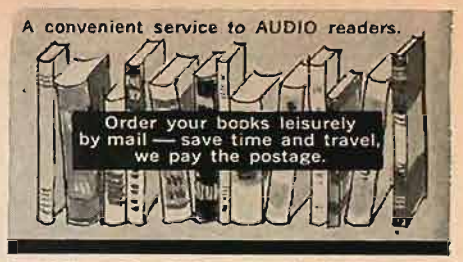
Dr. Dutton (EMI) writes:

"The major recording companies in Europe met on November 28, 1957 at Zurich to pool our information and discuss the relative merits of the 45/45-*vs.*-the hill-dale/lateral system. It was decided unanimously to recommend the 45/45 system and I then attended a meeting of the technical committee of the RIAA at Indianapolis at which I reported the recommendations of the European meeting and as you know these appeared to be in full agreement with those of the RIAA."

By April, 1958, nine companies in the U. S. were making and releasing 45/45 stereo discs. The 1958 NAMM Show in July was a clean sweep for stereo records. Stereo tapes and tape machines in general were to have their worst year. The 7½-ips two-track stereo tapes at $12.00 to $16.00 each were no match for stereo discs of the same tunes at $4.95 and $5.95. The two- and three-track master tape at the record company didn't care whether it made stereo tapes or stereo discs. But the people making tape machines cared a great deal! Something had to be done. A good stereo tape (sometimes hard to find) lasted for countless playings, and didn't have pops and ticks. But records were a lot easier to use.

RCA Victor didn't care which it sold, discs or tapes, just so that the transaction was profitable. They had by that time quite an investment in tape duplicating equipment (*Fig.* 8) which suddenly wasn't very busy. So after a frantic several months, these machines were modified to make tapes at 3¾ ips instead of 7½, and to lay down four tracks (two in each direction) instead of two on a ¼-in. wide tape, while maintaining the same frequency response and almost the

Fig. 8. High speed stereo tape duplicating, 1956, at RCA Victor, 24th St., New York City. **(Photo courtesy Bill Miltenburg.)**



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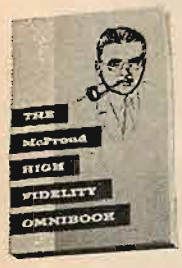

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same signal-to-noise ratio. This revision reduced the raw tape cost, the most expensive part of a tape recording, by a factor of four. The RCA bidirectional tape cartridge was then put on the market. Cartridges sold for about $7.00 to $8.00. Then the fight was on between reels and cartridges. Who had a cartridge player? People who had tape equipment had reel-to-reel machines. And besides, the 3¾-ips tape didn't sound quite as good as the equivalent and still cheaper disc. The cartridge itself was expensive, comparatively. A blob of vinyl for an LP stereo disc cost about 20 cents compared to a cartridge and raw tape which cost about 90 cents. The music cost the same. The processing of tapes was a mite cheaper than the injection molding of a good disc.

From this environment sprang the 7½-ips, four-track tape on 7-in. reels with a better frequency response, and which most people could play on their reel-to-reel machines if they bought a new head. The price for this 4-track tape wasn't bad, and tape began a comeback. Nevertheless, stereo discs sales soared. Their popularity was established. You could get a pretty good stereo disc player for around $100.00, compared with that old 3-track cylinder job of 1900 at a 1962 price of $4000.00.

The Monterey, California, first annual Jazz Festival held on October 4, 5 and 6, 1958, featured the first known three-channel "p.a." system used outdoors for unobtrusively reinforcing sound. Three-track recordings of the event were also made. This was reported completely in a previous issue of this journal.[9] One event stands out upon recall. While the Dave Brubeck group was performing, a low-flying airliner, seeking the nearby airport, roared overhead. Dave, as the plane's roar diminished, spliced into his performance a few significant bars of *Wild Blue Yonder* without missing a beat, to bring down the house.

After looking back at the strides made in the past 60 years in this field, anyone would be foolish to say, "we have now achieved perfection." For the past four years, CBS Laboratories and 3M jointly have been working to achieve a small tape cartridge approximately 2½-in. x 2½-in., filled with ⅛-inch wide tape running at 1⅞ ips with two-track stereo recorded thereon, and intended to sell for less than a disc. A self-threading machine to play it on is a part of the program. But it isn't available yet.

Well, what's next? If you want an inkling as to what's likely to be next, try to get hold of a book by E. S. Meade called "The Big Ball of Wax" published by Simon & Schuster. This is a prediction of what might happen in 1989 in this field: The sensory input sections of one's brain will be electrically connected to the output of a tape recorder. The experiences possible, as recorded by

others from their brain waves, are tremendous! Some of them are described in the book!

It's going to be fascinating to see what does come next, isn't it? Æ

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(from page 72)

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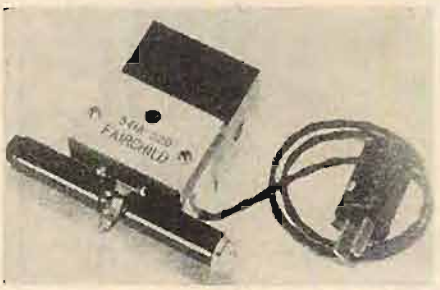

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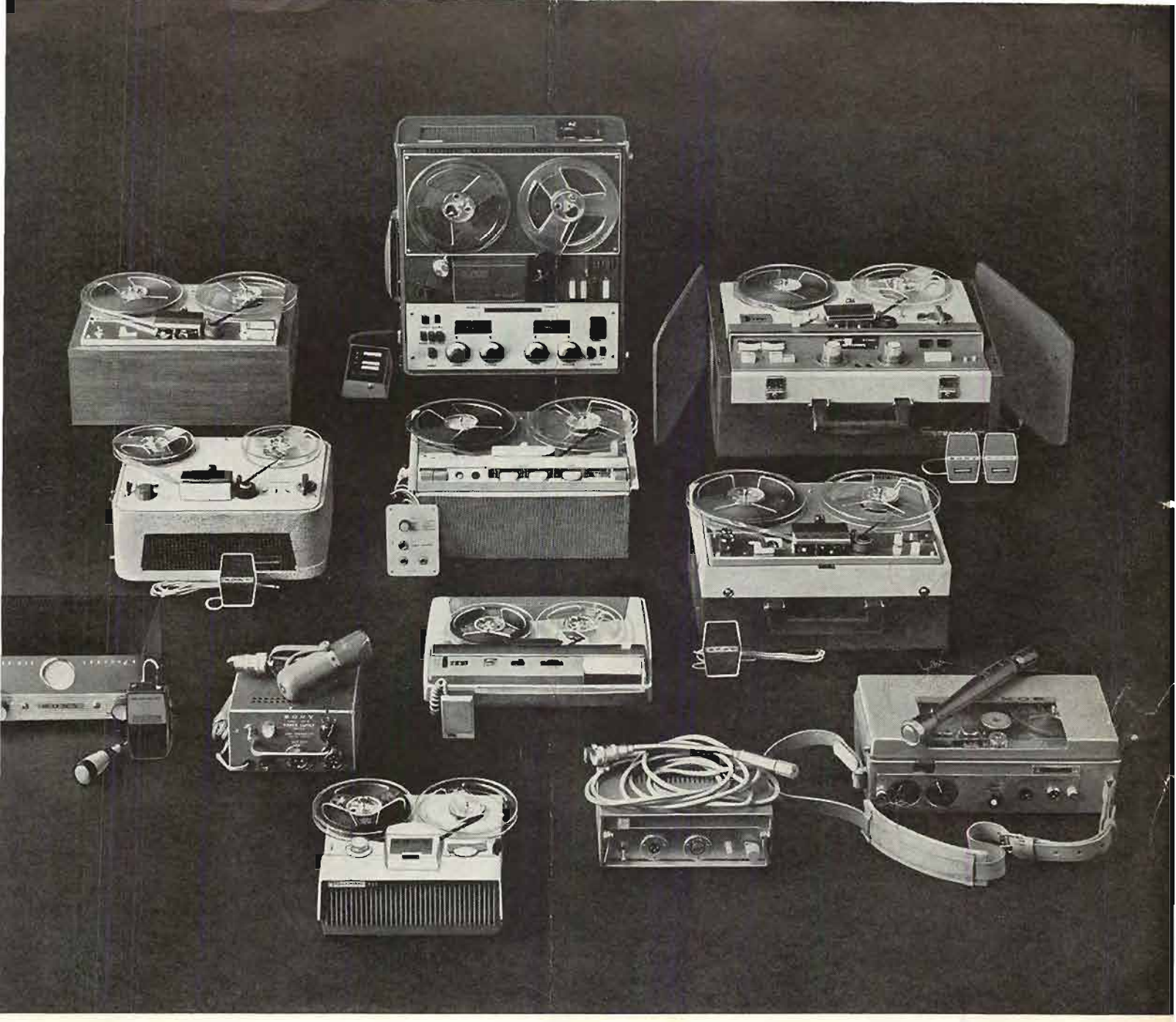

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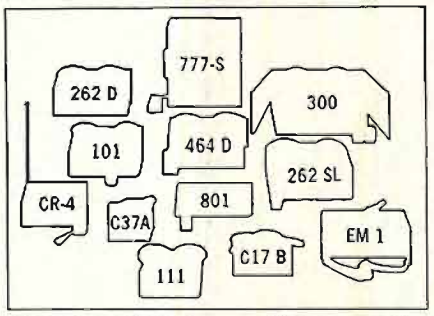

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